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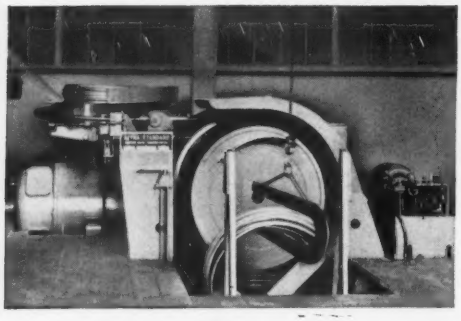
Another page for **YOUR BEARING NOTEBOOK**



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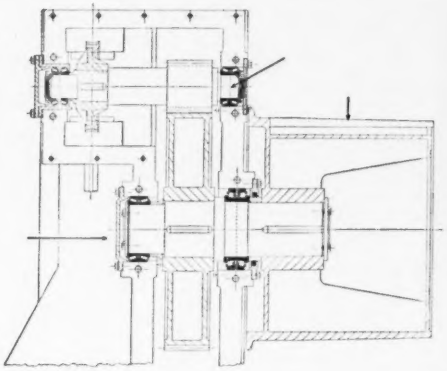

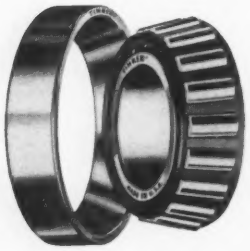

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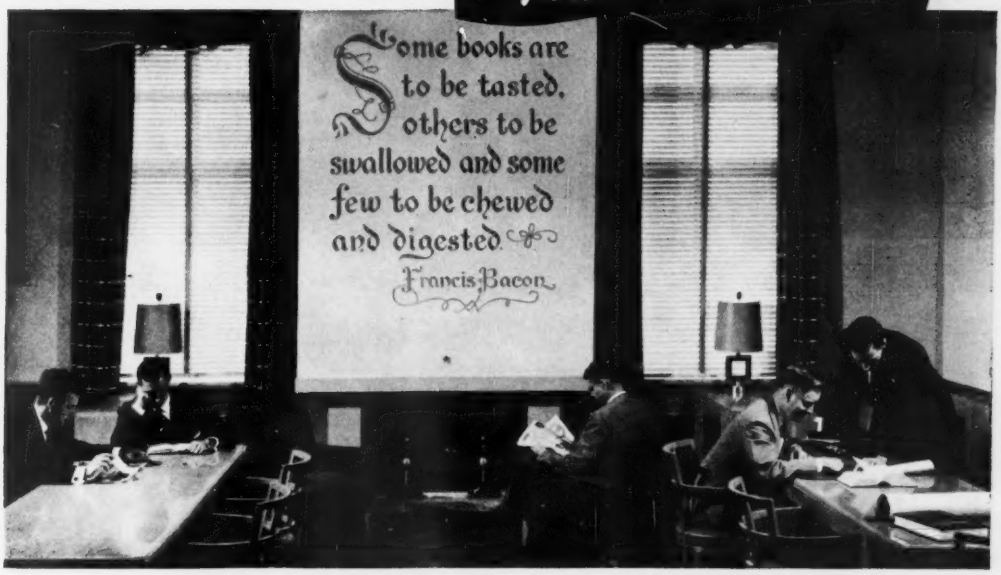

To get a quick start on the road to success, engineering graduates who join Westinghouse start with an orientation and training program at the new Educational Center. The reading room shown above is one of the many facilities available at the new Center. To aid in carrying out the program, there are also modern classrooms, auditorium, cafeteria, hobby rooms and recreation areas.

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A major part of the Plan is the Graduate Student Training Program. It has been carefully developed through 50 years to enable top men, selected in leading colleges, to choose their careers wisely from the wide variety of opportunities available at Westinghouse. This method enables you to become a responsible factor, quickly, in one of America's great industrial organizations.

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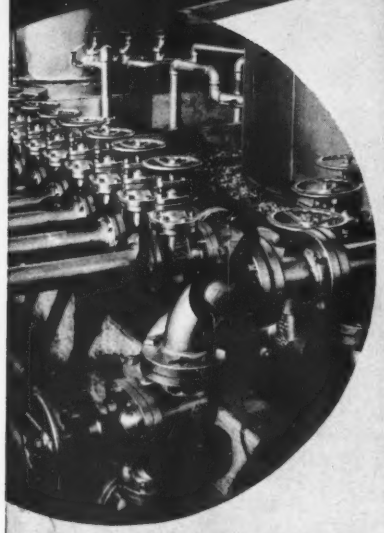

SOME OF THE 3000 JENKINS VALVES installed at the new research center. Many structural innovations, designed to simplify maintenance, are unique in this plant. Tunnels between buildings carry all pipelines; make them readily accessible. Air-conditioning system supplies 100% fresh air to laboratories at all times. The administration building, shown above, is one of 14 major buildings on a 100 acre site.

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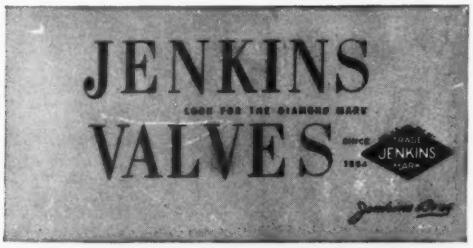

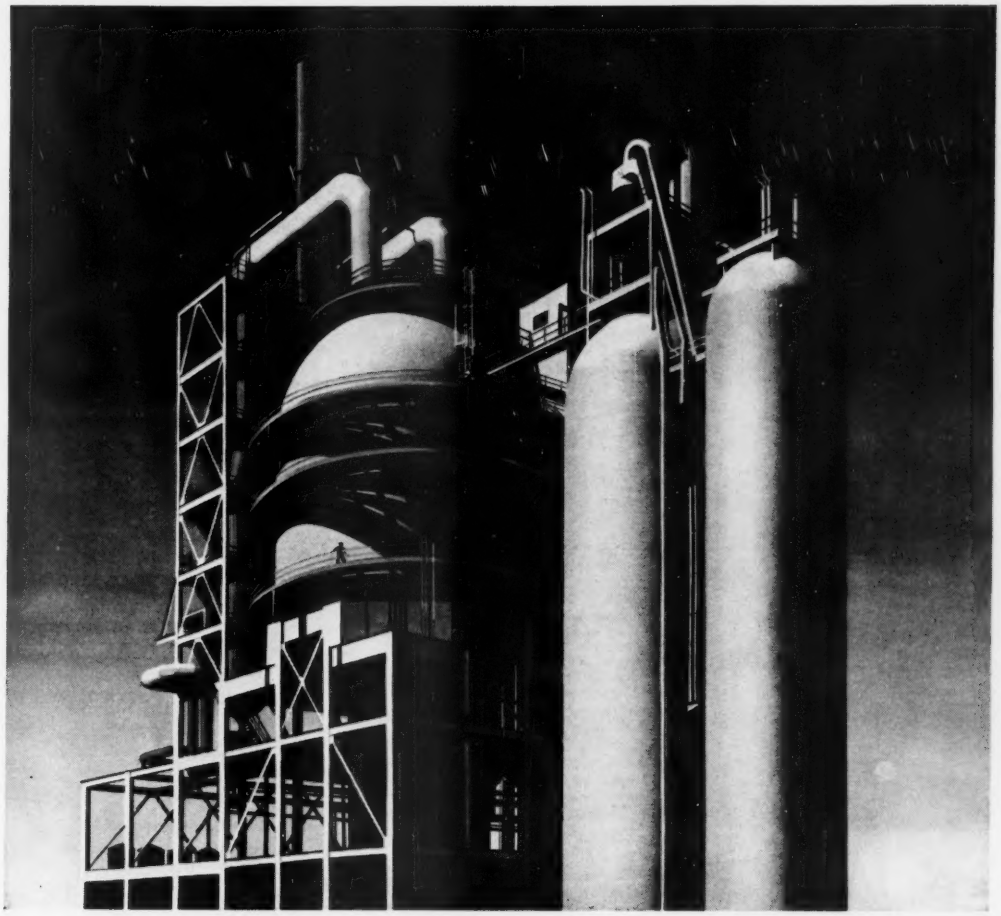

What's behind this giant "Cat Cracker"?

This catalytic cracking plant is in operation at Linden, N. J., refining oil products for Esso Standard Oil Company.

This behemoth can produce 1,520,000 gallons of liquid power *every day* . . . that means more heat for homes, more fuel to operate factories and farms, more power to make the nation's wheels go 'round . . . better living for everybody.

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"No mud on *our* Pulpit!

"No . . . not in our *little church!*

"But something the Pastor said reminded me of a service I'll never forget. Later, Helen told me I'd said *'Mud!'* out loud. That's why she dug me in the ribs and said *'John, wake up!'*

"I guess I *was* wool-gathering. I was back overseas, listening to a Chaplain who'd found a spot of beauty in a grove of trees for his services . . . right smack in the middle of a war! The green branches made a church-like arch. The sun filtered through the branches like through our church windows.

"The Chaplain's pulpit? Just the hood of a homely Army Jeep . . . *splattered with mud.* No organ music . . . just the booming of big guns far off. No pews, either . . . just mud to sit in. But I felt just as close to God then as I did last Sunday in our Maple Street Church.

"After Helen nudged me awake, I thought of countries where mud *is* slung at pulpits. Where men of the cloth are jailed. Where churches are closed or burned. And where God is disowned. I gave thanks that *here* we respect *all* churches.

"Freedom of worship is *one* of our precious rights. Other Freedoms include our right to vote as we please . . . and without anyone knowing *whom* we vote for. To get rip-roaring mad when we see our taxes wasted by wild spending . . . and when we read about charges of corruption against public officials. To choose our own jobs, like I did when I applied for one at Republic. To own our own homes. To drive our own car across state lines with nobody to push a gate down in our faces.

"I said an *extra* prayer last Sunday: *May our Reverend Johnsons, Father Kellys and Rabbi Cohens always have that sacred Freedom to preach their gospel from unmuddied pulpits. Amen.*"

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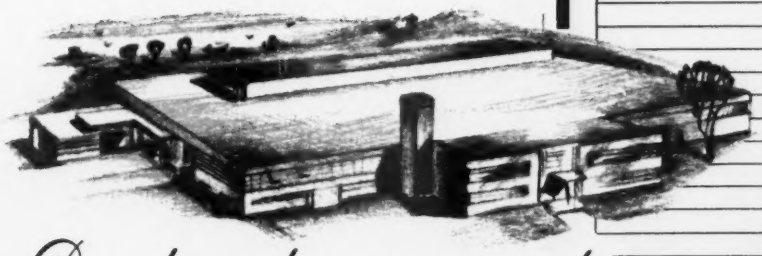

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something new in engineering education

Course XIV — Economics and Engineering

By Prof. Ralph E. Freeman

Chairman, Department of Economics and Social Science

Some years ago I recall talking with a man who had recently graduated from the Institute. He was already "successful" in the sense that he had real accomplishments behind him in the firm for which he worked and a future which promised even greater responsibility and rewards. He told me:

"I'm convinced that I got a good education at M. I. T. Technically, my preparation has left little to desire and, for most of the engineering jobs in our company, I'd be well equipped. But for the particular kinds of jobs that have been coming my way, there are some pieces missing in my training."

What were these missing pieces? This man's problem arose from being placed in a job where his engineering skills — and they were very considerable ones — weren't quite enough to give him the confidence he sought as a problem-solver. He told, for example, of an early disappointment which he had had. With all of the vigor of the young engineering graduate, he had tackled a challenging assignment of re-engineering the entire packaging process in the company's production department. He was — and is — convinced that the proposals which he offered made good engineering sense. But two things went wrong. The "boys upstairs" sat on his suggestions for a long time and finally requested drastic modifications which gave more specific weight to factors of cost analysis, revenue potentialities, and the overall product strategy of the firm. No one specifically said to him, "See here, you were expected to act as an economist on this problem as well as an engineering methods man." But he felt that the company's officers were disappointed that he had not more readily anticipated and grappled with the interplay of engineering and economic factors that underlay the problem.

The second thing that went wrong appeared only after he had revised his proposals in view of their economic implications. The old enthusiasm for his work was returning as he began to see the fruits of his efforts take shape in the form of new machinery and layout in the packaging department. But he soon found himself crushed and bewildered because the workers in the department refused to "accept" the changes on which he had spent so much energy. "Resistance to change — it's an old story," the old-timers in management told him. This didn't satisfy him; somehow he felt that he ought to have anticipated this problem, he ought to have understood why the workers reacted as they did when they faced the shiny new machinery, and he ought to have known what experience others have had in solving problems that have both engineering and human relations aspects to them. Some of these things he did learn in the difficult sessions which preceded the final installation and successful acceptance of the changes. "But," he concluded, "there's a lot more that I need to know. That's what I mean by the 'missing pieces' of my education."

At the time I heard this story, there was little that I could do beyond sympathizing with him and suggesting that we now tried to fill in some of these pieces through the M. I. T. undergraduate Humanities and Social Studies program. Today there is much more of an answer that I can give to the undergraduate who wants to combine solid engineering training with a liberal measure of social science courses. That answer is Course XIV — Economics and Engineering.

In one sense, Course XIV represents a new concept of engineering education. The changes which it introduces into the more usual type of undergraduate program are somewhat sweeping in appearance. Yet in another sense the course is a logical outgrowth of the notion that some jobs in industry and in government are, by their nature, "engineering plus social science" jobs. An example might be the job of resident engineer for a foreign branch of an American oil company. Here the professional worker deals daily with problems which require intimate familiarity with petroleum engineering, the economics of the oil industry, and, as events in the Middle East are showing us more clearly, the social and economic background of the country in which he is working.

Certain questions come up again and again in our discussions with prospective Course XIV undergraduates. To answer them will serve to make clearer the underlying philosophy of the course as it now operates.

First, then, what training does the Course XIV student get in the social sciences? In general, the student in Course XIV substitutes approximately a year of social sciences for engineering. To begin with, there is a core of four subjects which are taken by all such students. Two of these introduce the student to economics; another to the quantitative side of social sciences — statistical analysis and accounting for private firms and for the whole economy; and the fourth to the effects of the social structure on an individual's attitudes and activities.

These core courses are designed to give (1) an elementary knowledge of the economy and society in which the individual and firm operate, and (2) an introduction to social science techniques and analysis. A student can then elect up to seven additional courses in his junior and senior year. These electives make it possible for him to direct the emphasis in his program toward industrial economics or toward industrial relations, although work in both fields is encouraged. This additional work can lie in such areas as personnel administration, social psychology in industry, economics of invention and innovation, industry studies, international trade and finance, economics of government activities, and the like.

Second, what price does the student pay for this training in the social sciences? Is his engineering training so reduced that he cannot qualify as a professional engineer? Some sacrifice of engineering studies is clearly necessary in order to provide for this study of social sciences. But in each of three engineering fields, mechanical, electrical, and chemical, the basic courses have been retained. In general, the more specialized elective subjects have been eliminated. Sometimes a student

(*Continued on page 24*)

"keep it quiet but..."

Rumors: A Vital Concern to National Security

By Peter Embree, '55

Wartime intelligence and community stability depend on the ability of people to perceive, retain and report information. In community life, information is passed from person to person and becomes distorted in many ways. This distortion is basic to rumors.

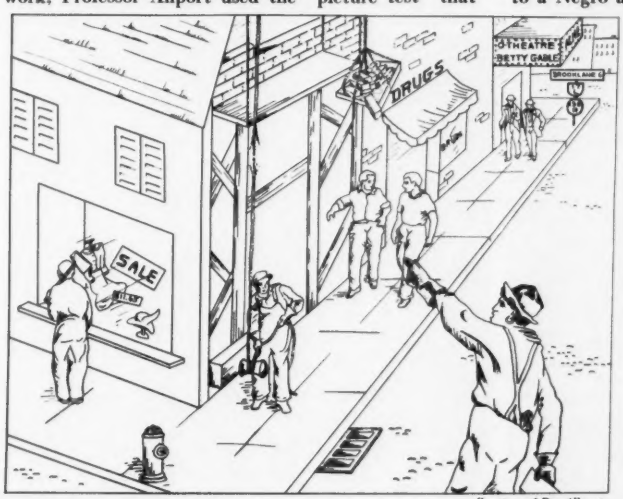
In 1942, just after Pearl Harbor, and for the next few years, the communities of our country were overrun with rumors. These were important factors in wartime morale. An optimistic rumor could lead to dangerous complacency, while fear rumors could create a defeatist attitude.

At this time there had been very little research done on the questions of how rumors spread, their classification or the determination of their significance. As a result of the evident need for work in this field, Professor Gordon Willard Allport of Harvard University and three associates undertook the task. These four people without a cent of subsidy made a significant contribution to science and public welfare.

The research problems of studying rumors are similar to those encountered in other social sciences. There are no spic and span laboratories, no graduates, scales, meters or other convenient standards by which to measure rumors quantitatively. A researcher could perhaps plant a rumor but it would be practically impossible for him to follow it at every stage in its progress, follow its distortion or record the speed with which it is propagated. But on the other hand, it was possible to do much work in a qualitative way.

The methods they used included collection, classification and interpretation of wartime rumors, and classroom experimental work. In this experimental work, Professor Allport used the "picture test" that was first used by Binet in 1900. The picture test was used to discover how distortion occurs and what forms it takes. The standard procedure in picture tests is as follows: A slide is projected in full view of an audience, an "eyewitness" describes the picture as he sees it, including approximately twenty details to the first of a group of six people who have not seen and cannot see the projection on the screen. The other five are out of hearing range. This person is instructed to repeat what he heard as accurately as he can to the second. The second person repeats the description to the third, until all six persons have heard a description of the picture. The sixth person then repeats his version to the audience who have been listening to the reports in full view of the screen. The results are very interesting.

In these experiments it was found that three basic forms of distortion take place. The first is called *levelling*. In the process of levelling, the less relevant details are dropped. The number of details repeated drops from the original twenty to about five. The second form of distortion is called *sharpening*. In sharpening, the subject exhibits selective perception, or retention of odd wording. Movement is accentuated. The action is contemporized. For instance, one slide depicted people standing in a subway train without holding on to anything, the train was obviously not moving. Yet in the majority of *terminal reports* the train was described as being in motion. The third process in distortion is called *assimilation*. The material is given an orientation in space and time. It is assimilated to self interests and distorted to the individual's folkways. In the subway slide, a white man was talking to a Negro and holding an open straight razor in his hand. In the Terminal Reports 'the razor was located in the Negro's hand. This detail was assimilated in such a way, presumably because the subjects associated the carrying of open straight razors with Negroes. Another slide, in which the location was not identified, depicted some Negroes and a policeman carrying a night stick. In the Terminal Reports this slide was described as a race riot in Detroit. Thus it was given an orientation in space.



Courtesy of Dr. Allport

This slide is typical of those used in Rumor demonstrations by Doctor Allport. For terminal reports, see below.

The tendency to orient a report in such a way that it is more easily understood is called a "closure" tendency. The subject seeks to fit the information he has heard into a pattern that fits into his past experience. In the dynamic community situation the closure tendency is the most important form of distortion. Each individual in the rumor chain tends to stereotype, rationalize and interpret any information as he passes it along. Unfamiliar names and places are either

(*Continued on page 26*)

the meson

Predicted by Theory, then Found in Practice

By Edward A. Colbeth, '53

Two decades ago the world as we know it was apparently explainable in terms of three elementary particles: the electron, the proton, and the neutron. These were the particles of which the substances of the universe were built. Here, certainly, was a simple and wonderful picture of nature. Today, however, nineteen particles are known, and there may still be more as yet undiscovered. The meson is one of these particles.

In 1932, when the neutron was discovered by James Chadwick, atoms were thought to consist of a tight nucleus, made up of protons and neutrons, and a collection of electrons revolving around the nucleus. This was a very nice, clear-cut picture. However, there was the problem of explaining the nature of the forces which are responsible for holding the protons and neutrons in the atomic nucleus together. At the time, W. Heisenberg, who had suggested that atomic nuclei were built up of protons and neutrons, tried to account for intranuclear attraction by making use of the idea of wave-mechanical exchange forces which he had previously used to explain the optical spectrum of helium. These exchange forces have no counterpart in either classical or Newtonian mechanics and are the result of wave mechanics.

One of the general results of wave mechanics is that if any system can be represented by two or more states with the same energy, then the actual state of the system is more stable than these individual states. This means that there is an additional energy contribution, the exchange energy, which makes the system more stable. Therefore, it is equivalent to an attractive force. When applied to proton-neutron systems, which can exist in different states of equal energy, the result is that the proton and neutron must attract one another, due to the exchange force. A further consequence of this theory is that when the neutron and proton approach close enough for the attractive force to operate, neither particle is exclusively a neutron or proton. There is then a rapid exchange of charge between the particles. It was naturally supposed that this electric charge was an electron, either positive or negative. However, since nuclear forces operate over such small distances, of the order of 10^{-13} cm., and the minimum effective range of a force involving an electron is about 10^{-11} cm., some new idea had to be proposed.

This new proposal was not long in coming, for in 1935 a new type of field was proposed by the Japanese physicist Hideki Yukawa. It was to consist of quanta of energy, which might take the form of particles of a certain mass, and might explain nuclear forces. Yukawa said that the two chief forces known, electrical and gravitational, could be explained in terms of emission and reabsorption of light quanta and gravitational quanta respectively. Because nuclear forces are of a different type, i.e., more powerful and operating over much smaller distances, he suggested the new type of field, which was to be responsible for nuclear forces. Using the fact that nuclear forces act over such a short distance, Yukawa estimated that the mass of the field quanta exchanged between two nucleons, was about two hundred to three hundred times that of an electron. These field quanta he called mesons, which were thought of as a binding material holding together the neutrons and protons in the nucleus. The mesons are regarded as the carriers of energy quanta in the meson field, similar to the carrying of energy quanta in an electromagnetic field by photons. Due to the presence of three types of strong bonds in nuclei (proton-proton, neutron-proton, and neutron-neutron), he predicted that there would be three kinds of mesons: positive, negative, and neutral.

In 1936 and 1937, scientists in the United States discovered the presence of positively and negatively charged particles having a mass of about two hundred times that of electron. Here, then, was experimental evidence that there were such things as mesons; it might now be possible to explain nuclear forces.

However, ten years later, after a great deal of experimentation, a discrepancy was discovered in Yukawa's theory of nuclear forces. It was found that although a great number of mesons were produced by incoming cosmic radiation in the upper atmosphere, they were not often absorbed by nuclei of atoms. The probability of production was 10^{14} times that of absorption. Not only did this contradict Yukawa's theory, but it also contradicted a general principle of physics, the reversibility of microscopic processes.

To clear up this situation, Marshak proposed in 1947 that there were two types of mesons. One, the heavy variety which possessed the properties that Yukawa had described and were responsible for the forces holding the atomic nucleus together; the other, the lighter variety, which was a decay product of the heavier mesons. This was the type that had been observed for ten years by experimenters in cosmic rays. According to this theory, the heavy mesons are produced by primary cosmic radiation in the upper atmosphere and decay into the lighter variety in about 10^{-8} seconds. In this time they cannot penetrate very far into the atmosphere and thus the light mesons are the ones chiefly found at sea level. These can be absorbed by atomic nuclei only with great difficulty. The strong production and weak absorption and interaction of mesons might be explained by this.

Shortly after this proposal, actual photographs of heavier mesons were taken at high altitudes in the Bolivian Andes. It was found later as the result of experiment that heavier mesons interact strongly with protons and neutrons, while the lighter ones do not. The heavy meson (called π-meson) has three forms: positive, negative, and neutral. The charged π-mesons have a mass about 276 times that of an electron. The neutral π-meson is somewhat lighter than the charged π-mesons (about eleven electron masses). Two forms of the lighter meson (called μ-meson) have been found, positive and negative, having a mass of about 210 times that of an electron.

(*Continued on page 34*)

the m.i.t. women's dorm

By Margaret Hughes, '55

Photographs by Dan Brzezenski, '53

So you don't know about the girls' dorm? Well, it's about time you did. Often referred to as 120 Bay State, you will find it is one of those repetitious four-story brick houses which endlessly line the streets of Boston. When full it holds seventeen girls, and at present contains sixteen and a house mother. There are seven double rooms and three singles. It is pretty much like any girls' dormitory with a few important exceptions.

Let's see . . . the score's just about even.

Waiting for a taxi on a cold morning.

Most of us probably first heard of the place by reading about it in some of the M. I. T. information sent us before we came. Half are freshmen, and as you might expect, many of us, especially those from a distance, came here because we thought it would be a good idea to live in a dorm at first to get used to the place. Some were obliged to stay here by their parents, and still others are here because they didn't realize what they were in for. A few of us very soon found that we did not like the situation here, and so had some idea of moving out for the second term, but the authorities made this extremely difficult no matter what reason was offered.

I might begin by indicating what a school day is like at the dorm. We get up at various times, probably ranging from early in the morning for the few who ever get up to study, to half an hour before one's first class for those who just can't seem to get up until the last minute. If we want breakfast, we get down to the dining room, usually in bathrobes, at seven-thirty, where one of the girls will be cooking it. It is also possible to make lunch if there is time. There are four ways of getting to and from school. The most usual is to walk; it is a bit over a mile. I think the distance is about the biggest disadvantage of living in the

Buzzing the girls for dinner.

This particular chore seems rather pleasant to the girls.

dormitory, because it makes it impossible to get home for supper if one happens to have a meeting of a student activity to attend or if one wants to go to any one of a number of lectures that occur at five o'clock at the Institute. If the weather is bad enough we take taxis, for which purpose a former Tech co-ed has left money. We can also take the bus or hitchhike; the usual method of hitchhiking is to wait until a car stops for one or more boys, and then get in with them. As I am not concerned here with what goes on at school, I will skip to the returning.

We leave school any time from after the last class to late at night. Supper is served at six-fifteen, but it is possible to eat leftovers if one gets home not too late and if there are any left. One thing I am glad of is that it is not an unpardonable offense to be late for supper. The house mother says grace, which is tolerable for those who appreciate it, but something I consistently try to avoid usually by arriving at the table after it's been said. I would much prefer having a short

It's kind of hard to keep up with the boys, so the data is dutifully recorded.

Hmmmm . . . that meat should be ready by now.

period of silence before starting so the girls could say grace to themselves if they wished. I don't hear too many complaints about the food, and although too salty for my taste, the general opinion seems to be that it's cooked well. After supper three of the girls clear, wash, and dry the dishes. Some of them will talk, play cards, read magazines, or listen to the radio before cracking the books.

On weekends I'm usually not around much myself, but I have an idea what goes on then. If one doesn't go away, weekends are a good time to wash clothes, write overdue letters, and make up back homework. Some of the girls go to church on Sunday, and some of them sleep late. Meals are served on weekends as well as during the week, and for some reason Sunday dinner is above average.

(*Continued on page 46*)

help wanted!

Employment Patterns Established by M. I. T. Alumni

By Paul Simmons

Edited by Raymond D'Arcy, '54

This article is an abridged version of a thesis written as partial requirement for a Master of Science degree in Business and Engineering Administration. It is hoped that members of the student body may find information that will be of aid, or at least of interest, as they contemplate their own postgraduate activities.

In September, 1947, the Alumni Placement Bureau undertook to send over thirty thousand questionnaires to all former M. I. T. students whose addresses were known and who had attended the Institute for one semester or more. The information requested was: title of position, department or division of company, name of firm, and products of the company with which the alumnus is concerned.

The information contained on the twelve thousand returned questionnaires was coded and placed on I.B.M. cards. Each individual was coded according to field (type of industry); subfield (specific industry); function (type of work or position); company; and M. I. T. course, class, and degree. There were eighty-six fields and more than five hundred functions coded.

Although nearly twelve thousand questionnaires were returned, the eighteen thousand unreturned questionnaires may introduce some source of error if some group, such as the least successful graduates, failed completely to answer. The meagre amount of information requested, as well as the general nature and other usual errors of mailed questionnaires (misleading information, difficulties of evaluation, and the like) provide the main sources of error in the work.

It became evident at the beginning of the investigation that it would be necessary to limit the scope of the study to selected groups. It was decided, therefore, to concentrate on the employment patterns being established by graduates of the Departments of Mechanical Engineering, Chemistry, Chemical Engineering, and Business and Engineering Administration. In order, however, to make comparisons between the employment patterns established by the graduates of these departments and all alumni, it was decided to present certain patterns being established by the alumni as a whole.

For want of a better term, "Field" is used to designate types of industries and spheres of activity in which Technology alumni are employed. Obviously, such a classification could range from a long, unmanageable list of specific industries to such broad designations as "Professional" and "Business." In this study, the field designations employed are those devised for the Alumni Placement Office as a means of classifying alumni.

According to the 1947 survey the field of business services (including the sub-fields of industrial engineering, advertising, trade associations, research organizations, legal services, testing and inspecting laboratories, engineering service contractors, Chambers of Commerce, and personal service) led all others by a respectable margin, both percentage-wise and in total number of alumni thus engaged. Over 1400 reporting alumni (12.1%) were employed in this field in 1947. It is unfortunate that many alumni are not coded according to sub-field. Of those who are, more than three times as many are reported in research organizations than any other sub-field. It is somewhat surprising to note that slightly over two hundred of those coded by sub-field were with trade associations. Since roughly one-third of all alumni answered the questionnaire, it would indicate that more than 600 alumni (1.6%) were with trade associations in 1947.

Since the field of business services looms so large in the total picture, a further breakdown is shown below:

TABLE I

FIELD OF BUSINESS SERVICES BY SUB-FIELDS

Sub-Field	*No.*	*Percentage of Major Field*	*Percentage of All Returns*
Industrial Engineers	101	7.0	.9
Chamber of Commerce	6	.4	—
Trade Associations	203	14.1	1.7
Advertising	33	2.3	.3
Testing, Inspect. Lab.	10	.7	—
Engin. Contractors	56	3.9	.5
Research Organizations	613	42.6	5.2
Legal Services	77	5.4	.6
Personal Services	103	7.2	.9
Not Coded	236	16.4	2.0
	1,438	100.0%	12.1

As shown on Chart A, the next largest field of employment for Technology alumni is the federal government, with 801 alumni represented. State and municipal employees bring the total working in the various echelons of government to 8.3%. Teaching (6.6%), chemical manufacture (5.0%), electrical equipment (4.8%), and machinery (4.5%) conclude the list

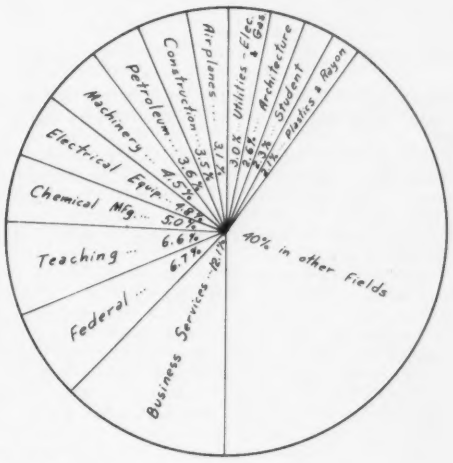


Chart A

help wanted

of fields reported by more than 500 each. These six fields account for 41.3% of all those reporting, with the remainder scattered throughout the other seventy-nine fields.

Of the one hundred alumnae who answered the questionnaire, 62% were in just three fields: 28% in teaching, 21% in business services, and 13% in architecture. The classification of housewife is not included.

Of the four departments studied most intensively, graduates of the Department of Chemistry demonstrate the greatest tendency to concentrate — 48.2% being engaged in the three fields of chemical manufacture, business services, and education, with one out of every four being employed in the single field of chemical manufacture. This represents the single largest concentration of field of any category studied. Moreover, graduates of this course with an S.B. degree tend to find employment in a rather restricted number of fields. Although the ten top fields of all alumni account for a total representation of 53%, or an average of 5.3%

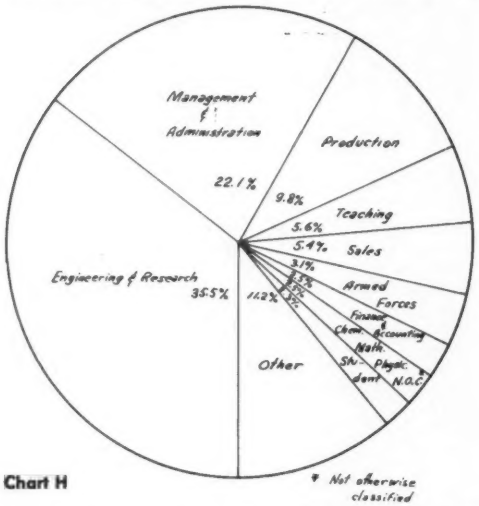


Chart H

per field, the ten top fields for graduates of Course V account for a total of 70.9%, an average of 7.1% per field.

It should be pointed out that Course V differs quite considerably from most other courses in percentage of doctor's degrees awarded. The average for the Institute — 1910 to 1947 — is 4.3% of all degrees awarded. In the Department of Chemistry the figure rises to 31.4% of Course V graduates.

Next in field concentration are graduates of the Department of Chemical Engineering with 42.2% in the three fields of chemical manufacture, petroleum, and business services. The single fields of chemical manufacture again predominate with 18%. However, they are more widely scattered than Course V graduates, appearing to strike a medium between fields popular with graduates of Course II and Course V.

The main difference in field between graduates of Course X and Course V appears to be in the fields of petroleum and teaching. Whereas 14.9% of Course X graduates work in the field of petroleum, only 4.3% of Course V graduates are so employed. The situation is reversed in the field of education, with Course V showing an 11.2% representation while only 3.9% of Course X graduates are represented.

Graduates of the Department of Mechanical Engineering gravitate primarily to the fields of machinery, business services, and government, with 27.7% thus engaged. It is not surprising to find, in view of the comparatively broad curriculum, that Course II graduates were engaged in virtually every field of employment. Of the eighty-five designated fields, Course II graduates were found in all but six. Course II graduates differed significantly from all alumni only in the field of machinery, with 12.4% employed in this field compared to 4.5% of all alumni.

The tendency of graduates of the Department of Engineering and Business Administration not to concentrate is clearly demonstrated by the fact that only 21.7% are found in the three top fields of business services (10%), machinery (7.5%), chemical manufacture (4.2%).

It is not so strange that there are, proportionately, fewer Course XV graduates in the field of business services than the average 12.1% of all alumni, because of the fact that this field is composed largely (42%) of those alumni who are employed in research organizations, which is classified as a sub-field of business services.

It should be remembered, too, that Course XV is the only group studied in which there are no doctor's degrees awarded. It appears that the higher the level of education the more likely was concentration in a limited number of fields.

The major reason that Course XV graduates tend not to concentrate in particular fields, it seems, is that the variety of subjects studied is quite wide. One would naturally expect to find graduates of a course offering both engineering and business subjects working in more fields than graduates of a predominantly technical course.

The previous section was primarily concerned with the industry fields in which M. I. T. alumni find employment. In this section data will be presented to show what functions, or type of work, alumni are engaged in. It is evident, for example, that general administrative functions, engineering functions, sales functions, etc. must be carried on in the various fields. This section, therefore, deals with the functional activity of alumni according to type of work and job positions.

The coding system developed for the Alumni Placement Bureau, which was used to code all questionnaire returns, lists more than five hundred different functions. This presents a problem in grouping. After considering many alternatives, the writer came to the conclusion that the most logical grouping appeared to be the following: (1) engineering and research, (2) management and administration, (3) production, (4) teaching, (5) sales, (6) armed forces, (7) finance and accounting, (8) chemist, mathematician or physicist not otherwise classified, (9) student, and (10) all other functions. The first nine groupings account for 380 specific functions, with the remaining 120 plus making up that group designated as "other."

Perhaps the most difficult functions to group were those in the area of administration and management. It is certain that technical directors, works managers, treasurers, controllers, sales managers, chief engineers — to name a few — perform some administrative and managerial functions. However, since the administration-management is composed wholly of those alumni

(*Continued on page 36*)

industry's rubber carpets

Conveyor Belts Save Money, Time, Effort

By Tom Cantrell, '55

Everybody has seen a conveyor belt at one time or another. Basically, they appear to be ridiculously simple. Take a hoop of flexible material, stretch it over two drums, one of which is powered, and you have a conveyor belt. But these simple conveyor systems move an astounding amount of material, and in certain situations have unique advantages over other types of transport.

The essentials of a conveyor are: (1) the belt, (2) the idlers, rollers which support the belt, (3) the head and tail pulleys, which change the direction of the belt, and are the points of power application, (4) the supporting framework.

Engineering problems of belts

A belt must have great strength along its length. Stretching makes large take-up mechanisms necessary, which are expensive and hard to construct in constricted locations.

It must have enough flexibility to pass over pulleys with minimum distortion and wear. Lack of flexibility causes breakage.

Another property essential for many operations is *troughability*. This means the belt must lie well on idlers which tilt the outer edges of the belt upward, forming a moving trough.

Therefore a belt is an animal that must have great tensile strength in one direction and flexibility in the other two directions.

The surface requirements of the belt vary. Belts handling ore, coal, and fill receive their greatest wear when the material is dumped on the belt. Conveyors for package goods have specially roughened surfaces so the goods may be moved up and down relatively steep inclines. Oil resistance or heat resistance may be required in specific applications.

Each installation presents different demands on the belt. A belt which can store up a large static electricity charge would be dangerous where explosive or dusty products are handled; a material that will not affect the taste of foods is essential for belts used in canneries.

A conveyor flight may be defined as the section of a system which consists of one belt. A system may contain a number of flights, just as a stairwell contains many flights of stairs. A long flight is desirable for a multitude of reasons. Reduced wear is the main one. A given point on a belt on a long flight passes over the pulleys less often, increasing the flex life. It also passes the loading point, the source of most surface wear, less often. If the belt is carrying a material which is crushed easily, and loses value as it is crushed (soft coal), a small number of points of transfer from one flight to another reduces opportunity for damage. The number of motors, pulleys, slack take-up mechanisms and controls needed for a system is reduced by the use of long flights.

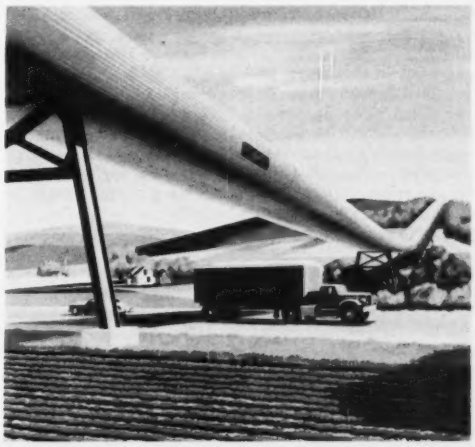
Another factor in increasing belt life is the load per foot of length. A belt which can carry more pounds per foot can deliver equivalent tonnage while moving at a slower speed than one with a lighter loading. This cuts wear in the same manner a long flight does, and in addition enables more uniform loading. Wear on idlers and pulleys is reduced also.

So you see our simple flexible hoop presents a number of very real and knotty engineering problems.

Conveyor Belt Engineering

The problem of providing high tensile strength in one direction and flexibility in the other directions has been approached in several ways.

The oldest type of belt, and one that is still much used, is the one in which the load-carrying element is



cloth. A cross-section of the belt reveals that it is built up of alternate layers of duck and rubber. Cotton duck has been used for many years, but recently rayon duck has been utilized with success. For high-temperature work, glass-fibre is used.

About twenty years ago a new approach was tried. Rows of rope were laid side by side running lengthwise in the belt, and fabric was used in the outer layers of the core. Thus the rope was used to take the tensile stress, but did not stiffen the belt transversally. This kind of belt has good troughing properties.

Greater tensile strength was desired. When aircraft steel cable (used for rudder and elevator operation in planes) was developed, its properties proved to be useful in belts. It is strong, flexible and of small diameter. The wire is brass plated for improved adhesion in rubber, and used in the same manner that the rope was in the older type of belting. It is this kind of belt that makes long-distance hauling of ores possible.

The surface requirements of the belt determine the specific type used. Abrasion resistant covers are desired for ore and coal handling belts. Belts which carry packages and other smooth surface items need rough surfaces like a "stucco" or "duck impression" to provide a high coefficient of friction for transport up inclines.

industry's rubber carpets

On surfaces which will be covered by oil and grease, covers of neoprene plastic or "Chemigum" (Goodyear trade name) are used. These covers are designed to resist softening and swelling caused by oil.

Uses of Conveyors

A conveyor does its job best when handling a material which is loaded on at a steady rate, and is not damaged by transfer from one belt to another. Coal, ore, and crushed stone obviously fit this description well. In coal mines conveyors have replaced electric mule cars, and do a much more satisfactory job, especially in old workings where rail trackage had been poorly planned.

In open pit mines a conveyor which carries the ore to the surface removes the need to take railroad cars down into the pit, thereby saving both time and money.

Cross country transportation of ores and fill has been the most spectacular utilization of conveyor belts. The first major long distance haul was the removal of Denny Hill from the center of Seattle. The dirt was dumped in barges to be emptied in Puget Sound. The longest belt ever built was ten miles long and used to haul fill to Shasta Dam. The longest system now in operation is the seven mile belt at Bull Shoals Dam, also used to move fill. Single belt flights of more than two miles have been used. There appears to be no mechanical limit to the length of conveyor systems.

In factories conveyor belts are employed to carry components along assembly lines, in shipping rooms and storage areas. High friction surfaces enable goods to be handled with maximum safety.

Economics of Conveyors

For use in coal mines, conveyors are more expensive to install and operate when the hauling distance is less than four miles. However, if the trackage must be laid in a circuitous route, as is the case in many old pits, a conveyor belt may be more economical.

For above ground use, a conveyor system is generally more costly to construct than a railroad right of way, but for distances of less than fifteen miles, may prove cheaper to operate because of the expensive terminal facilities which a railroad must maintain.

For most economical operation, a near-full loading at all times is needed.

Thus it may be seen that a conveyor is not by definition the most economical long distance transport device, but that the material to be hauled, the traffic density, the terrain, and the distance are determining factors.

In the Future???

Two of the more ambitious projects proposed for conveyor belts are the Riverlake ore conveyor and a Times Square-Grand Central Station passenger shuttle.

The former project is to consist of northbound and southbound belts enclosed in an elevated tube, running from Lorain on Lake Erie to the steel mills of Youngstown and the Ohio River, a distance of one hundred thirty miles, including proposed branches.

The traffic which this conveyor is planned for is Mesabi iron ore bound for Youngstown and coal from the Ohio River for Great Lakes ports. All of this material is at present moved by rail.

The backers of the belt line offer to deliver coal in Youngstown more than a dollar a ton cheaper than railroads do and iron ore at more than fifty cents a ton less. They claim that this would enable the Youngstown mills to better meet the prices offered by mills located on rivers.

The belt would consist of 172 flights on the main line from Lorain to East Liverpool on the Ohio River. These flights range in length from 2,000 to 3,800 feet. The northbound belt for coal will be wider than the sixty inch iron ore belt running south. The estimated cost at the time of first proposal, 1949, was $210,000,000. This estimate has since risen. The top estimate is $355,000,000 plus as computed by engineers employed by the Special Transportation Committee, made up of twelve railroads in this area.

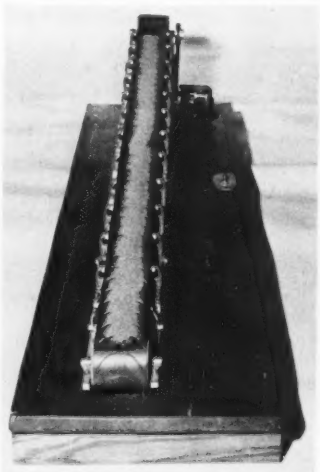
Moving at a rate of 600 feet a minute, the belt would have a potential capacity of 32,000,000 tons of iron ore per year southbound, and 20,000,000 tons of coal northbound.

Bills have been presented to the Ohio legislature to give conveyor belt companies right of eminent domain. Here is where the battle is pitched between the railroads and the backers of the belt line.

The railroads contend that by its very nature a conveyor belt is not and cannot be a common carrier, for whom the right of eminent domain has been reserved. They say that the Riverlake line is designed to handle only a select market and would constitute, in effect, a private transportation system for the steel companies.

The railroads also state that if they are deprived of the income from ore and coal handling, the quality and expense of general railroad service will suffer.

Other economic arguments against the belt are presented by the railroads. They point out that it would erase the price advantage enjoyed by coal mined in Ohio by bringing in better quality coal from Pennsylvania via the Ohio. The conveyor would employ many fewer people than the railroads. The reduced income of the railroads would be reflected in the reduced taxes they would pay to counties and the state.



Model showing ribbed top conveyor handling wet material.

The backers of the belt line offer arguments on the same grounds but in the opposite direction, saying that it will create new jobs, increase tax revenues, be a national defense asset, aid the Ohio coal industry, and increase industrial development. The conveyor's big stick, however, remains the promised large savings to iron ore consumers and industries using steel.

The Times Square-Grand Central Station shuttle conveyor is proposed to replace the present subway shuttle, occupying the same tube. The crosstown shuttle has been a bottleneck for many years.

The plan of operation is best explained by describing what happens to one passenger as he enters the station at Times Square.

The station platform is a con-

(*Continued on page 44*)

Pi

The Elusive Number

By Donald Eckhardt, '55

If an astronomer were to calculate the volume of a sphere whose radius is equal to the distance from the sun to Pluto, the outermost planet of our solar system, and the value of π used were correct to fifty decimal places, the error involved due to π would be less than one millionth of a cubic inch. Yet π has been calculated to 707 places! And of what use is such accuracy? Absolutely none.

This calculation is far advanced over the earliest known record of the value of π, the Ahmes Papyrus. This work of about 1700 B.C. states that the area of a circle is equal to the square whose side is the diameter diminished by one ninth. This would give $\pi = 256/81 = 3.1604\ldots$.

The Babylonians and ancient Hebrews used the very rough approximation $\pi = 3$. In the Old Testament, 1 Kings 7:23, is found the passage,

"And he made a molten sea ten cubits from one brim to the other; it was round all about, and a line of 30 cubits did encompass it."

Many of the ancient Greeks occupied themselves with the classical problem of the quadrature of the circle, that is, the construction of a square whose area is equal to that of a given circle, using only a straight edge and compass. The first Greek to treat the problem mathematically was Archimedes. He inscribed in a circle and circumscribed about it regular polygons of ninety-six sides, and then by geometry determined the lengths of their perimeters. The perimeter of the circle was larger than the perimeter of the inscribed polygon and smaller than that of the circumscribed polygon, and so he proved that $3\ 10/71 < \pi < 3\ 1/7$. This method is the equivalent of the formula: $\sin\theta < \theta < \tan\theta$ where $\theta = \pi/96$. It is remarkable that Archimedes was capable of making these calculations despite the utter backwardness of Greek arithmetic.

Four hundred years later, Ptolemy (87–165 A.D.) obtained $\pi = 3.14166$.

In India, Arya-Bhata (about 500 A.D.) gave $\pi = 62832/20000$, while in China the great astronomer Tsu Ch'ung-chih (born 430 A.D.) proved that 10π lies between 31.415927 and 31.415926. The Arabic mathematician, Alkarism, stated that 22/7 is an approximate value, $\sqrt{10}$ (3.162. .) a value used by the geometricians, and 62832/20000 a value used by the astronomers.

In 1220, Leonardo Pisano, who was one of the first Europeans to use the Arab system of numerals, took $\pi = 1440/458\frac{1}{8}$, or 3.1418, by choosing the mean result between the circumscribed and inscribed 96-agons of Archimedes.

The first explicit expression for the value of π was given by Vieta, who in 1579 proved a formula equivalent to

$$\frac{2}{\pi} = \sqrt{\tfrac{1}{2}} \cdot \sqrt{\tfrac{1}{2} + \sqrt{\tfrac{1}{2}}\,\tfrac{1}{2}} \cdot \sqrt{\tfrac{1}{2} + \tfrac{1}{2}\sqrt{\tfrac{1}{2} + \tfrac{1}{2}\sqrt{\tfrac{1}{2}}}} \cdots$$

Using the method of Archimedes with $6 \cdot 2^{16}$-agons, he found π correct to nine places. Fourteen years later Adrian Romanus, using a regular polygon of 1,073,741,824 sides (a 2^{30}-agon), found the value of π correct to fifteen places.

In Germany, where π is often referred to as "Ludolph's number," Ludolph van Ceulen (1539–1610) devoted much of his life in carrying π to thirty-five places. By his directions he had this value engraved on his tombstone which has been lost.

The last man to use the method of Archimedes was Grienberger, who in 1630 found π to thirty-nine places.

Most of the later calculators have used converging series based on James Gregory's (1638–1675) theorem:

$$\theta = \tan\theta - \tfrac{1}{3}\tan^3\theta + \tfrac{1}{5}\tan^5\theta - \ldots$$

This series was also discovered independently by Leibnitz after whom the particular series

$$\frac{\pi}{4} = 1 - \tfrac{1}{3} + \tfrac{1}{5} - \tfrac{1}{7} + \ldots$$

is named.

Using Gregory's series, Abraham Sharp in 1699 found π to 72 places, and in 1706, Machin, Professor of Astronomy in London, used Gregory's series and the fact that

$$\frac{\pi}{4} = 4\tan^{-1}1/5 - \tan^{-1}1/239$$

to calculate π to 100 correct places.

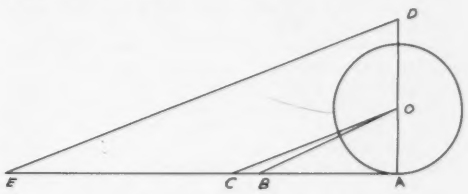
De Lagny in 1719 went to 127 places (112 correct) and Vega in 1789 reached 143 places (126 correct).

In the middle of the nineteenth century the calculators really started grinding away. In 1841 Rutherford gave π to 208 places (152 correct). In 1844 Dase went to 205 places (200 correct). In 1847 Clausen carried it on to 250 places (248 correct). Rutherford in 1853 stretched his calculations to 440 places and in the same year, W. Shanks, not to be outdone, calculated π to 607 places using Machin's formula. Finally in 1873 he found π to 707 places.

Of course, no matter how accurately Shanks hoped to find the value of π, he was probably aware of the fact that it could only have been an approximation; in 1761 Lambert proved that π is irrational. And in 1882, Lindemann proved that π is transcendental, from which follows the proof that the quadrature of the circle is impossible.

An approximation of π can also be found by dropping a match stick on the floor a few thousand times. If the stick is of length L and on the floor are ruled equidistant parallel lines distance d apart, where $L < d$ the probability that the stick will fall so as to lie across one of the lines is given by $2L/\pi d$.

The quadrature of the circle has been proved impossible, but there exist some constructions which give approximately the true answer. This construction was given by Jacob de Gelder in 1849.



Given: circle O with radius OA
Construct $AB = (2+1/5)OA$ on the tangent at A
Construct $BC = 2/5\ OA$
Take $AD = OB$
Draw DE parallel to OC.

Then

$$\frac{AE}{AD} = \frac{AC}{AO} = \frac{13}{5}$$

(*Continued on page 44*)

the miracle of the broom closet

By W. Norbert

Everybody has his own Mexico. For some it is seafishing in Acapulco with the usual photograph of the fisherman and the fish. I believe the fish take as much pride in the photographs as the fishermen, only under the ocean things are turned upside down, and the pride of the fish is in the weight and size of the American who appears beside him. Others sit on the lawns at Cuernevaca and bask in the sunshine. I suppose that on weekdays they are prominent leather manufacturers from Mexico City or famous doctors; but I have merely seen them in their basking costumes with their wives and children up from the City in play suits of Jim Tillet's black patterns. I am told that there are even a few people in Mexico who go up Popo, and a slightly smaller number who come down again. However, I do not wish to assert what I have not observed with my own eyes.

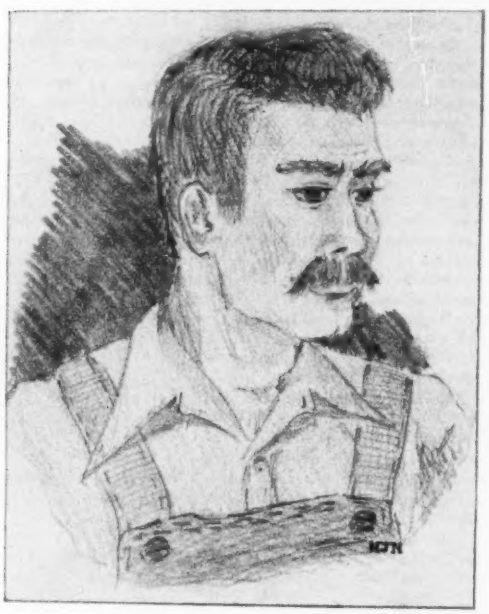
For me Mexico means none of these. Instead, it means a severely formal and efficient building, with plumbing painted in three different colors, and the universal odor of the experimental laboratory. It means working with a friend of mine who is a physiologist, and who will not be named in the sequel for reasons that will appear obvious. It means a highly energetic and competent group of young men of various nationalities, who are not averse to playing occasional tricks on one another, and who pursue their several careers as physiologists, chemists, and other varieties of scientists. There is also Sebastian.

Sebastian is the janitor. I do not mean to imply in the least that he is an ordinary janitor. In fact, he is the janitor to end all janitors. When I first met him, he was possessed of a flowery conversational style, and two equally flowery moustachios. The moustachios, alas, have passed into history, although I suspect them of having been stolen by one of the younger chemists. The style is still there.

When I first met him, Sebastian was only able to be flowery in one language. As a matter of fact, the general question asked in the laboratory when a new article is to be turned over to the press is, "Is this the way that Sebastian would have said it?" Since then, with the ebb and flow of foreign and largely North American scientists, English has become the second language of the laboratory, and Sebastian can manage to be quite as dignified in it as he can be in Spanish. He holds very high opinions as to the responsibility and the conduct of "international scientists" and speaks reverently of them.

Sebastian is thus an internationalist, but he is not himself an unnational being. He is most definitely a Mexican, and a very devout one at that. There is a shrine in the broom closet, not unlike the portable affairs that Mexican chauffeurs carry around with them on the front window; and I need not tell you that the Saint to whom he prays is his namesake. I don't mean that there is not a portrait of the Virgin of Guadaloupe somewhere in the Shrine — that would be too much to expect of a patriotic Mexican — but the main figure is that of a Roman soldier pierced through and through with arrows and looking very uncomfortable under the circumstances.

I must now report to you a sad event which happened some few years ago, and almost caused the disruption of our flourishing little institution. It all goes back to a visit the Boss paid to the National Pawn Shop. Why the Boss should visit the National Pawn Shop is more than I can understand, but I believe that it was under the pressure of some of his wife's American friends, who had heard there were to be found there rather remarkable opportunities for the purchase of Colonial jewelry. However, one of the lots to be auctioned off seemed to consist of a miscellaneous collection of hardware, and to be so little in demand that it was going to be knocked down at a ridiculously low price. There is always a need for odd bits of metal around a laboratory, for clamping the different parts of an apparatus together; and as about fifteen pieces



of miscellaneous junk were to be knocked down for half a peso, the Boss couldn't resist the need of supporting the financial interests of his laboratory.

Most of the stuff was no use to anyone — it consisted of a few things that looked like picture frames, some miscellaneous brass work and a few bits of junk jewelry — but there were some iron rods which caught my friend's attention as just what he needed for the assembly of his new oscillograph. The oscillograph is located in the back of the room just opposite the broom closet I have mentioned, where the janitor keeps his wash rags and brooms, and performs his private devotions.

It is the part of the ideal scientist to keep a magnificent impartiality in his decisions; but although this is so, in a long career extending over forty years and three continents, I have never met the ideal scientist. The very least he wants is to get publishable results, and what he usually wants is to show that Professor So-and-So of the University of Patagonia has made a fool of himself in his last paper. Much as I admire my esteemed Mexican colleague, I cannot acquit him of a full measure of human frailty in such matters. He

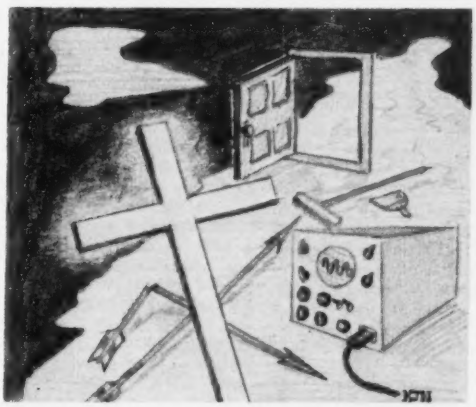
is quite as capable of chortling as the next man, and his long and successful scientific career has given him many occasions to chortle.

In the period in which this tale is laid, Professor Halbwitz, formerly of the University of Spiesburg, and now a refugee at the University of Patagonia, had presented a paper concerning nervous conduction which contained some features highly obnoxious to my friend. The dispute began with the fact that the Patagonian scientist used a certain German make of amplifier, while the Mexican scientist swore by an American amplifier which a friend of his had constructed. At any rate, there was a marked discrepancy between the results of the two men. For a while, my friend put it down not only to the other fellow's bad instrumentation, but in particular to the electrodes he was using. I may say bad electrodes or polarized electrodes are the continual excuse of the electrophysiologists.

Before long the whole laboratory knew that the combat between their director and Herr Professor Halbwitz was a grim battle to the death. The less respectful youngsters had heavy bets on the outcome, weighted decisively, I may say, by the fact that their boss had almost always come across in the pinches. On the other hand, as becomes a man of dignity and substance, the janitor, our Sebastian, was unable to relieve his emotions in such a trivial and undignified way. The Boss over whom he watched, the Boss who was a national asset of Mexico, the Boss to whose office he had often brought the bootblack and the barber — much, I may say, to the Boss's embarrassment — not only could not be wrong, but by some sort of contradiction, he needed the full support of Heaven in not being wrong. Far be it from me to expatiate on the fluency of the prayers which went up to Saint Sebastian. Neither the fluency of Sebastian's Spanish nor my own linguistic abilities permit me to do justice to the subject. At any rate, the first results of this devotion were most gratifying. The Mexican electrodes seemed to work perfectly, and the American amplifiers were all that a committee of Edisons could have wished. The paper proceeded flowingly; it seemed as if H. Halbwitz was doomed to be swallowed into the outer darkness in which he belonged.

Convincing as the results of our laboratory were, they appeared to have no effect whatever on the stream of publications arising in Patagonia. In one article after another, Herr Professor Halbwitz continued to maintain his indefensible thesis, and the controversy went on for a period of months. By this time somebody in the Morganbilt Institute in New York began to be intrigued by the blank opposition between the results of the two scientists. He was an old friend of the Boss, and we had full confidence that the results of our laboratory would be completely confirmed. We got a most apologetic letter from the Morganbilt Institute, in which our friend, Dr. Schlemihl, confessed himself unable to duplicate our results. He supposed that there had been some misunderstanding on his part about our setup, but as far as his work went, it seemed to be distinctly on Halbwitz's side. A long letter from our laboratory did not improve the situation. It appeared that Schlemihl's understanding of what we had done had been perfectly correct. It was really a nasty situation, because the controversy came to take on a rather personal tinge, and there wasn't anything we could do about it. An article appeared in an Argentine newspaper commenting on the corruption of Mexico by North American contacts, and declaring a national mission of Argentina to be at the lead in all branches of science and intellectual effort. This was followed by a rather chauvinistic article in the Journal of the American Medical Association, casting doubts on all Latin-American work.

We still kept getting the same results. The Boss began to look more and more strained. I don't know how we could have kept from an explosion if just about this time a totally new and unexpected piece of work of his in an entirely different field had not come off, and saved the reputation of the laboratory. Still it



was a close thing; and to this day the name of Halbwitz is not to be mentioned in the laboratory without a certain feeling of humiliation.

It was only the other day that we got our first clue as to where the difficulty really lay. The Boss was looking over the collection of junk that he had bought a little more carefully before throwing it out as utterly useless. In the bottom of the box, between two flat pieces of metal, there had sifted down a little slip of parchment, indicating that the box had been the property of an old Mexican priest who had excavated

(*Continued on page 50*)

tech engineering news

Professional Journal of the Undergraduates of the
Massachusetts Institute of Technology

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from the editor's notebook

Let's Hear From You . . . . .

The *Tech Engineering News* is written primarily for you, the student at M. I. T. It is written to entertain you, to inform you about news of technical fields and also about different phases of student life which would otherwise go unnoticed.

T. E. N. has not been a static organization. There are striking differences between the first issue published in 1920 by the Managing Board of *The Tech* and the present magazine. As late as 1939 *T. E. N.* was written solely by outsiders, by men in industry, and by experts in different fields.

I do not believe that the magazine has reached its final form. On the contrary, changes must be made as the character of the student body changes. The magazine should be continually scrutinized to determine where it can be revised to more closely meet your needs.

But this can't be done unless we know what you want. Do you want more technical articles? More about student life? Should the articles be shorter, longer, or just as they are now? Should we include more pictures? Would you like to see a monthly page written by one of the Deans at M. I. T.?

There are many changes which have occurred to us, and probably more which you have thought of; but it is difficult to guess just what the student body expects from *T. E. N.*, so let's hear from you. Please address your comments to *T. E. N.*, Walker Memorial Building.

S. K.

In the Next Issue . . . . .

Do you know what the average Italian college student thinks of the United States? Do you know the opinion of the majority of Italian students about communism? The *Tech Engineering News* conducted a poll, to be published exclusively in the May issue, which should help answer these questions, and many of the answers are shockers.

Another outstanding feature of the magazine will be a review of the latest developments in submarine warfare. This article has been compiled after extensive study of latest information released by the government, and with assistance from the Navy information service.

The Foreign Student Summer Project has been steadily growing in importance at M. I. T. This ambitious project brings foreign technical students here to use the facilities of this school for the summer. The results, which have been surprisingly good in terms of technical achievement and mutual understanding, are outlined in an article by one of the workers on F.S.S.P.

The heating of homes throughout the year by energy from the sun is a possibility. As a matter of fact, that principle is being used on an experimental basis at M. I. T. today. DR. MARIA TELKES, who has worked extensively in this field at M. I. T., outlines the progress made and the future potentialities in an article for *T. E. N.*

A discussion of the use of the theme of travel through time in science fiction stories written by Rudolph Preisendorfer should be of interest to all science fiction fans.

For the physics and E. E. majors, we include articles on computers and quantum mechanics.

Announcing the New Managing Board . . . . .

The *T. E. N.* Managing Board for the year starting September 1952 will include **Anthony Ranti, '53,**— General Manager; **John Mathis, '53,**— Editor-in-Chief; **Sherwin Kalt, '53,**— Managing Editor; **Charles A. Homsy** — Business Manager.

From the June 1923 Issue of T. E. N.

plans for the future

By Dr. Samuel W. Stratton

President of Massachusetts Institute of Technology, 1923–1930

Since its inception the Institute has always been noted for continual growth and progress. Its leaders have been men of exceptional creative imagination, foresight and courage, making possible the establishment of a scientific and engineering school which is unsurpassed by any similar institution.

However, Technology has not reached the limit of its development. It is still far from a full realization of the ideal of its founders. In keeping with the tradition of progress, therefore, every effort is being made to formulate and carry out plans which will bring us nearer to this ideal.

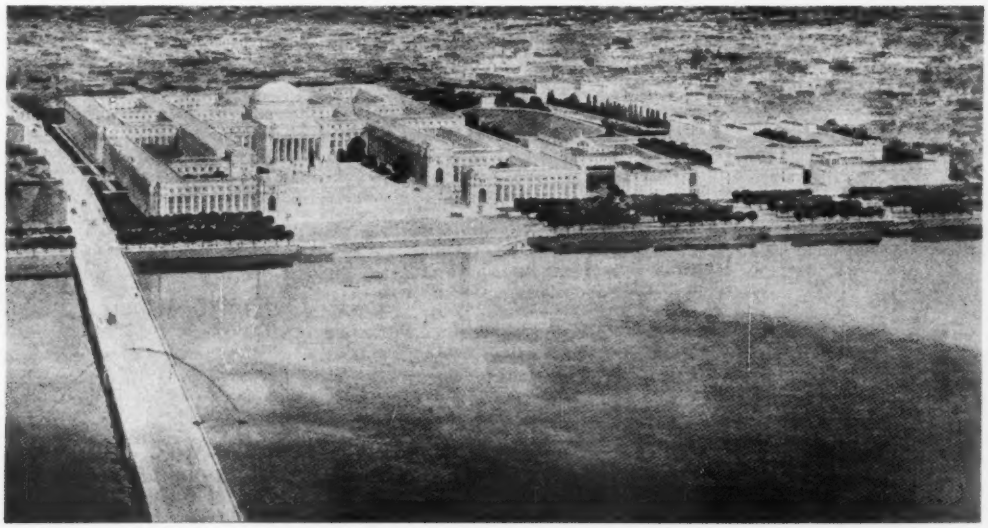
Whenever growth and development are contemplated in any organization the question of expenditure comes in. Adequate funds are necessary. In an institution such as Technology is at present, the funds required for expansion are necessarily large and must be obtained from without, which is usually a slow process, calling for an immense amount of effort. It is this factor of securing funds which frequently holds up progress. Therefore, it must be kept in mind that no definite time can be set as to just when the plans for the future, enumerated below, will be carried out to completion.

In considerations for the future development of the buildings, the question of adequate dormitories is among the most important. The Corporation, Faculty and Alumni are unanimous in the desire for more dormitories. Tentative plans are under consideration for the extension of the present dormitory system, utilizing the northeastern portion of the present grounds, just back of the Walker Memorial Building. This will not in any way interfere with the athletic field, but will help to finish off the grounds in that portion which is at present little more than dead space.

In connection with the educational buildings, there is an urgent need for a series of laboratories and workshops to provide for the heavier problems in connection with industrial research and engineering. Many of these problems, such as investigation of internal combustion engines, building materials, highway engineering, etc., require ground-floor solid foundations and convenient workshops. It is planned to meet this need by erecting a number of properly equipped buildings of a simple but semi-permanent design. These will be put up on the present grounds just in back of the main buildings. No further extension of the permanent educational buildings is contemplated at present.

The Institute needs a large building of simple construction which would adequately serve as a gymnasium and occasionally as an auditorium for large audiences. It would contain an indoor track and a swimming pool. The location would be on the present grounds, not interfering with the present athletic field, but near enough to make it available to the students at all times. Physical exercise during the winter months is a necessity, and its success will depend upon the accessibility of facilities. A swimming pool is one of the most useful and enjoyable means of providing winter exercise.

No remodeling of the Walker Memorial Building is contemplated at present. If a new gymnasium is built, it would relieve the present congestion and permit more



The New Technology?

Courtesy Technology Review

space for student activities in accordance with the original design. A provision for the addition of an auditorium and gymnasium was included in the original plan of the Institute, but the necessary funds are not available at this time for a permanent building of the required size and style for the location.

It is hoped that the Great Court can be remodeled in such a way as to make it a practical and useful approach to the main entrance without marring its landscape effect in connection with the architecture of the buildings. The present lack of a suitable approach renders the main entrance useless and confuses visitors coming to the Institute.

As to the educational work of the Institute, plans are under way for the introduction of such additional courses as may be necessary to cover the newer developments in engineering such as highway, sanitary and automotive engineering. It is hoped that the courses in Physics and Chemistry can be extended to include the advanced research work necessary to secure fundamental data for the various branches of engineering, and that the biological work can be extended to include more work in the investigation of food transportation and preservation problems.

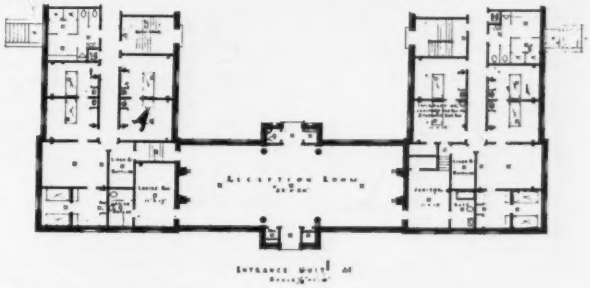
There is a demand in several of the departments for a longer course, especially for those wishing to prepare for research in science and advanced engineering. This will be met by offering more graduate courses but not at the expense of the regular undergraduate work.

Every effort will be made to strengthen the work in English. In this connection, the student should realize the value of being able to write and speak effectively. The business world is coming more and more to require this of an engineer, and it behooves the undergraduate to make use of every opportunity to perfect himself in this respect, much of which can be done outside the classroom by reading and participating in the various societies.

It is aimed to promote such cöoperation and interrelations of departments and courses as is necessary for the best interests of the faculty and student body. Endeavors are being made to determine just how each course can be improved.

The enrollment will only be limited by the number which can be adequately taken care of with the present equipment. The use of psychological examinations in helping to select men fitted for the Institute has been of too short a duration to determine whether they are successful or not. A further trial must be given them before they are either permanently adopted or rejected.

Only an outline of future plans can be given in this article. Each plan must be thoroughly studied and investigated before it reaches a final form. This entails bringing to light details far too numerous to be set down here. Enough has been given, however, to show that Technology intends to carry on its tradition of progress, going further each year towards a fuller realization of the aims and ideals of its leaders.



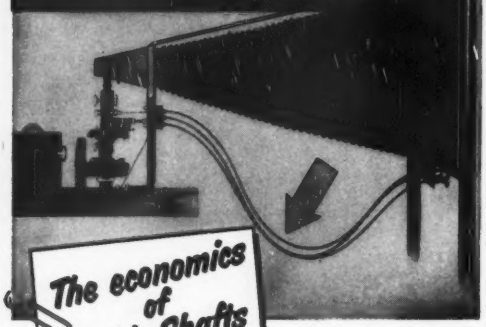
Bemis Dormitory Plan.

According to unofficial plans drawn by A. F. Bemis, '93, the new dormitories will be somewhat on the general plan of dorms recently erected at Harvard. They will embody some improvements over the present dorms and will be the very latest word in dormitory construction. (*Continued on page 32*)

The New Technology!!

Flexible Shaft Fingers 4 Feet Long

focus a microscope



When the manufacturer of this microprojector wanted to provide a means of focusing the microscope from control knobs mounted 4 feet away, he used S.S.White flexible shafts. No other method offered the same simplicity and economy. As for sensitivity, the flexible shafts fully satisfied all requirements, because they are engineered and built to provide smooth, easy control over distances of 50 feet or more.

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course XIV

(*Continued from page 8*)

comes to us with a request to do the engineering part of his work in some field other than the three just mentioned. This ordinarily presents no difficulty and we are able to work out a program for him with the particular department concerned. But the general rule still holds: the engineering subjects must give him the essential basis on which any professional engineer in the field would build.

Suppose, for example, that the student elects Course XIV-B (based on electrical engineering). He would take, with two minor exceptions, all the courses required of each electrical engineering major in Course VI. In addition, two engineering electives are provided in the Course XIV-B program for more intensive work in some specialized field. The price paid for social sciences, then, is specialized engineering courses; the basic principles of engineering are still included in the student's program. On this fundamental grounding can be built later specialization if it is found desirable. This point is particularly important in view of the fact that specialized undergraduate work so very often fails to be in the area in which the engineer actually works at some later date. But the engineer always works in a social situation; his understanding of people and society will be helpful in whatever he does subsequent to graduation.

Third, how does Course XIV differ from some of the other courses that seem closely related, such as XV and IX? Course IX (General Science and Engineering) has a different goal from Course XIV. It is designed to permit students to free themselves from the curriculum rigidities of particular engineering or science courses in order to pursue study goals involving fields that cut across several departmental lines. Course XIV, on the other hand, focuses on the study of one particular engineering area, and adds to this a substantial amount of social science.

While Course IX and Course XIV may be distinguished with some ease, it is harder for students to distinguish between Courses XIV and XV (Business and Engineering Administration). There are, however, important differences between the two programs, on the engineering side as well as in the social sciences.

The engineering emphasis of Course XV is on a general engineering and scientific background in the physical sciences or in the chemical sciences. Concentration in any one professional engineering field is discouraged. In contrast, the Course XIV program is designed to provide adequate engineering training for the student to operate as a professional engineer in one of the important engineering fields. Course XIV's essential goal is to supplement the training of a man who is basically an engineer.

The business administration side of Course XV places primary emphasis on the techniques of operating a firm — marketing, production, and the like. Course XIV, on the other hand, places its emphasis on an understanding of (1) the environment within which the firm must operate — on a knowledge of the economic and social system and on human behavior — and (2) the way in which this environment limits and modifies the activities of the firm.

Finally, what positions do the graduates of Course XIV hold? What work do they go into on graduation? Since Course XIV is of postwar origin, our employment experience is necessarily limited. Nevertheless, certain trends seem clear. The majority of our graduates go

(*Continued on page 26*)

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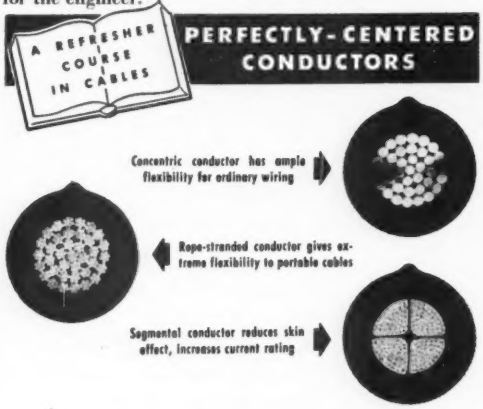
course xiv

(*Continued from page 24*)

into some phase of business activity. Generally, they are initially employed in some aspect of engineering — including such areas as product development, product appraisal, sales engineering, straight production work, and the like. In other instances our graduates have begun their industrial careers in management-training courses, going on from these to junior administrative posts in a plant. In still other cases, they have been employed in the Economics and Engineering sections of large corporations, in statistical and economic analysis of costs or revenues, or in departments concerned with personnel administration and industrial relations. For early success, some of these highly professional fields require some graduate work as a background as well as some experience on the job. Another group of our graduates have taken engineering and administrative positions in government and in universities.

Finally, a significant number continue on to graduate work in engineering, in economics, or in industrial relations. The engineering programs permit students to continue on to graduate work with little or no additional course work. Graduate work in either industrial relations or economics can be carried forward on the undergraduate grounding provided in these areas.

Altogether, then, a wide range of activities is open to the Course XIV graduate. This range of activities, in fact, illustrates the real breadth of the problem posed by the engineer mentioned at the start of this discussion. And the breadth of the Course XIV program is one of its two major strengths. The second is its open and continuing experimentation in a new type of education for the engineer.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OKONITE SINCE 1878

insulated wires and cables

"keep it quiet but . . ."

(*Continued from page 9*)

dropped or changed to familiar ones. In the slide above the man in the foreground is described initially as a foreman with earrings in his ears. In the Terminal Reports, he becomes an Italian workman presumably because Italians are not thought of as foremen! Betty Gable becomes Betty Grable.

These principles of levelling, sharpening, and assimilation have widespread applications in the psychological studies of recall, forgetting, imagination and rationalization. The picture tests have been used to study recall. The procedure is to ask a person to describe a picture that he has seen; if the interval has been short the description is fairly accurate. However, if some time elapsed between the stimulus and recall the description is inaccurate.

The above experiments were made in the classroom atmosphere of accuracy in the presence of audiences. Evidences of distortion always arise, and the demonstration is very effective in driving home the unreliability of fifth and sixth hand reports. Eye witness accounts, themselves, are unreliable. How much more unreliable must rumors be in the absence of an atmosphere of accuracy!

The general definition of a rumor is a specific topical proposition for belief passed from person to person by word of mouth with no secure standards of evidence. It deals with personalities and events, is concerned with hearsay of happenings, gossip, slander and prediction. Specific individuals named in rumors are almost always well known. Other personalities become stereotypes, i.e., "fat man," "Jew," "Negroes" or other unsubtle description. This stereotyping or undue simplification is the result of the levelling and sharpening processes which promote economy of mental effort. There can possibly be some kernel of truth remaining in a rumor, but if so it's probably some detail or movement, size, or symbol that has been sharpened or exaggerated.

Sometimes rumors are labelled facts to gain credence. The teller states he heard the story "from somebody who ought to know" or "on the highest authority." A few cautious people hedge their statements by saying "it is rumored." However, in 1932 Kirkpatrick conducted experiments that revealed that in a large group of subjects there was no difference in belief ratings between labeled rumors and unlabeled facts.

After a rumor has been repeated by a number of people its resultant meaning is common to all and its moral tone is characteristic of the culture in which it is found. After the fifth or sixth telling of the story it becomes sloganized and from there on the distortion of the remaining details is a minimum. Thus the shorter the original version the more accurate the resultant rumor tends to be. The central theme is least distorted. It was found that people tend to believe rumors in accordance with their preferences. In the year before Edward VIII married Wally Simpson a poll was taken asking people whether or not they thought that the King was going to marry and secondly whether they thought he should. Of those who thought he should, 80 per cent thought that he was going to while only 32 per cent of those opposed predicted the marriage.

Rumors tend to relieve, justify and explain tension, both in the individual and society. They fill emotional needs, gaps in conversation and help to eliminate

(*Continued on page 28*)

Power at your finger tip

Nearly everything you do today is done easier, quicker and better—thanks to electricity

If you are an average American worker you use the strength of nine horses each working hour of the day.

WHERE DO YOU GET SUCH POWER—Merely by flicking a switch . . . for by that simple act you are tapping the vast sources of electric energy that are ready to work for all of us in the home and on the job.

Today, the use of electric power has grown to where a single factory uses more electricity than an entire city used a generation ago. And your home—with its electric appliances, lighting and other conveniences—consumes more power than was used in yesterday's factory.

NEW MATERIALS WERE NEEDED—This great progress could not have been achieved without the many new and better materials which make possible today's larger and more efficient power generating equipment.

A JOB FOR ALLOY STEEL—Giant turbines and generators, for example, couldn't stand up under terrific heat, pressure, wear and corrosion if it weren't for steels made tough and enduring by alloying metals.

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"keep it quiet but. . ."

(*Continued from page 26*)

uncertainty and anxiety. In his book "The Psychology of Rumor" Professor Allport presents an illustrative formula pertaining to rumors — $R = (i) \times (a)$. This means, the greater the importance of the subject matter or the greater its ambiguity the greater the rumor. If either of these factors is zero the rumor does not spread. For instance, if I hear a rumor about the price of camels in Ethiopia, I do not repeat it, because although it is very ambiguous its importance is negligible. On the other hand, if I break a leg and a rumor comes back to me that I am dead, I do not spread it, for despite its obvious importance there is no ambiguity in the facts so far as I am concerned.

In 1943 Professor Allport issued a call for rumors in a national magazine. The response was over one thousand different rumors. These were studied with the idea of finding out what motivates the repeating of rumors. In accordance with the above formula it was found that most rumors at this time were concerned in one way or another with the war, a subject of great importance and ambiguity. About two-thirds of the rumors collected were hostile in intent and diversive in effect and could be called anti-Semitic, anti-Negro, anti-administration, anti-service, anti-business, etc. These hostility rumors or "wedge drivers" are indications of the insecurity of the teller in respect to the subject matter. The repeating of these rumors helps to justify to the teller the hostility that he feels as a result of this insecurity.

Another motive for repeating rumors is to gain prestige. For instance, it was found that some Italian-Americans during the war were listening to Radio Roma on short wave receivers and spreading Axis propaganda that they heard among their friends. Upon investigation it was discovered that these people had expensive radio receivers and gained prestige from repeating what they heard in the Italian broadcasts and that this prestige was the underlying motive.

Some rumors which could be called "home stretch" exhibit the goal-gradient effect. Have you ever awaited a phone call and thought that you heard the telephone ringing when it wasn't? This is the goal-gradient effect. The fact that you are expecting a phone call makes it easier for you to believe that the phone is ringing. Classic examples of this type of rumor are the peace rumors just prior to the Armistice in 1918 and just before V-E and V-J Day.

Other rumors resemble day dreams. They exhibit an effect known as complementary projection. This effect is a process of finding one's own sins in others and thus relieving the guilt feelings in oneself. During the war, for instance, it was a frequent rumor among housewives that the Army was wasting and throwing out large quantities of meat such as whole fresh sides of beef. In some way the repeating of this type of rumor helped the housewives feel a little less guilty about their black marketing.

Some rumors, however, exhibited merely an intellectual curiosity about one's surroundings. An example of a curiosity rumor would be: "I heard they are going to build a new army camp nearby."

In general rumors are believed and repeated because they help to relieve some kind of tension or help the individual to interpret his environment to himself. Incidents are made to fit a linguistic pattern and praise

(*Continued on page 32*)

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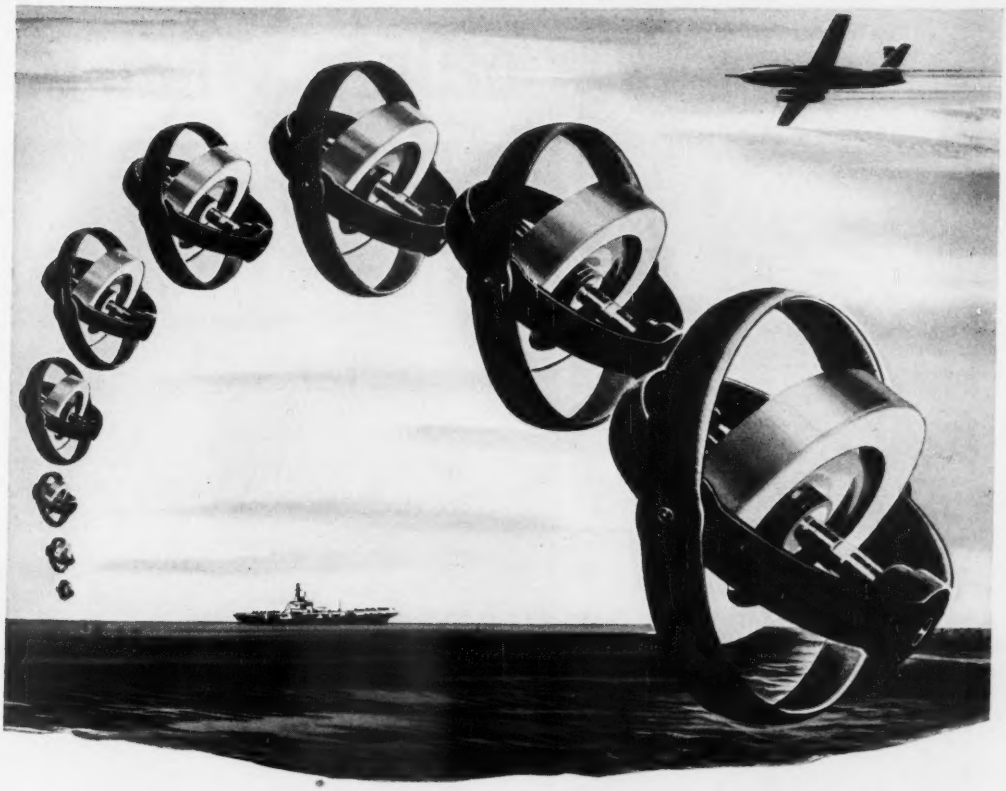

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MAN SIZE! When you can step into its mouth and look down its throat like this, you've got a scroll casing for a hydroelectric turbine that's really *big!* This one, of welded steel construction, has a 98-inch inlet, a 132-inch bore. It's made by United States Steel.

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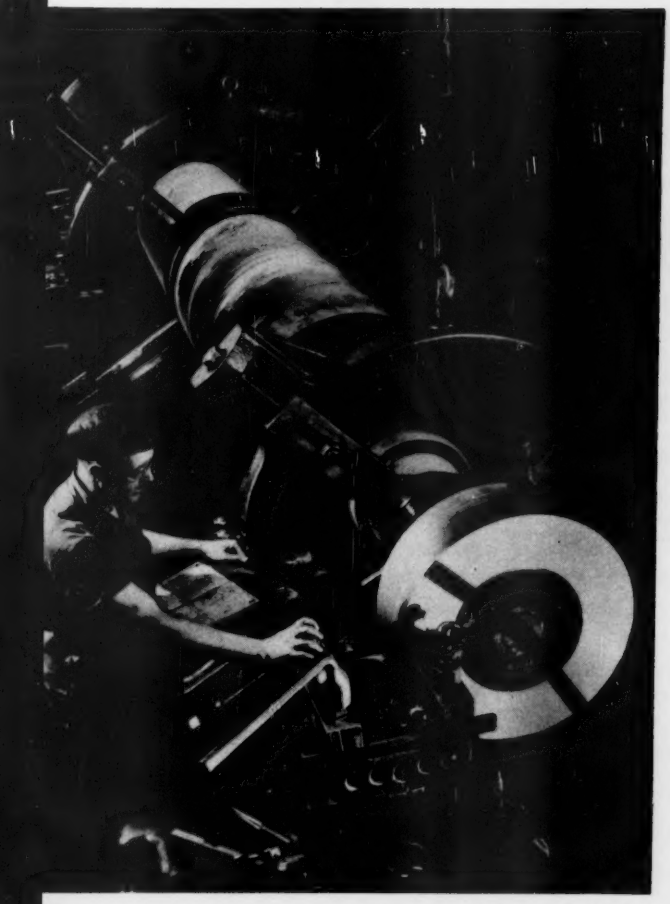

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FACTS YOU SHOULD KNOW ABOUT STEEL. In making the products that are sold under the United States Steel trade-mark, U.S. Steel buys materials from nearly 54,000 other companies . . . and over 40% of all money received by U.S. Steel for its products is paid out to these suppliers.

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"keep it quiet but . . ."

(*Continued from page 28*)

or blame is placed according to group standards. One woman relates that she had invited the Minister of Defense to dinner and had instructed the maid to have the home sparkling because the minister was coming to dinner. The maid later told her friends, "What a shame! They had the minister to dinner and didn't even take the cigarettes off the table."

Some rumors are started as a result of an effort after meaning. For example, a Chinese professor vacationing in a small Maine village asked one of the natives to tell him of a picturesque place to stay. The story got around that a Japanese spy had come to take pictures.

In a way legends are a type of rumor. Information about national figures of the past is both important and ambiguous. The details are levelled, sharpened and assimilated to the emotional needs of the community and the legend evolves about a national hero.

The speed with which rumors travel is roughly in accordance with the above formula. They are especially virulent in times of social strain. Two days before V-J Day a newspaper correspondent in Washington, as a prank, started a rumor that arrangements had been made for Emperor Hirohito to fly to Manila with a squadron of Kamikaze planes and thence to Washington, D. C., accompanied by B-29s. There he was to sign a peace treaty in the presence of the President and Cabinet. Six hours later the correspondent received a telephone call from a naval officer in California in regard to the rumor.

Some rumors last longer than others because of relative differences in the interests and information in a community. A rumor which was widespread last year may have disappeared today because of changed situations.

Rumors may be classified with regard to speed and periodicity in the following ways: creeping rumors, impetuous rumors, and diving rumors.

Included in creeping rumors would be hostility rumors and Cassandra-like reports. They are usually passed about with an air of secrecy and somehow they are heard by everyone. Impetuous rumors threaten or promise immediate violence, catastrophe or great victory. They spread like wildfire and die in a short time.

Diving rumors are rumors that occur under certain environmental conditions, disappear, and then reappear under similar conditions. Under this classification would be included the "tongue and stamp" story. This cropped up in both World War I and World War II. As the story goes, a prisoner of war wrote telling his mother to save the stamp. When the stamp was removed from the envelope a message was seen to be under it, saying "They have cut off my tongue." There can hardly be the slightest kernel of truth in this story, for prisoners of war do not use stamps and a man would die from loss of blood very quickly if his tongue was cut off.

Each rumor seems to have its own public or rumor chain composed of those people who are most interested in the subject matter. That is, financial rumors would be heard mainly on Wall Street and draft rumors among young men. One of the conditions for a rumor chain is a series of suggestible people in close contact. People are links in a rumor chain only if they are suggestible, while if they are skeptical by nature or training they wait for adequate information and secure standards of evidence.

Rumors thrive under conditions in which information on important subjects is missing or ambiguous. They can be refuted by complete statements and facts to the contrary. Thus in our modern times of radios, newspapers and other forms of communication, we have a better picture than our forefathers of the world around us. We are not so much at the mercy of serial reproduction and distortion. A large amount of history in the making depended upon rumor in the absence of modern communication. Yet today there are more rumors than ever because of our wider range of interests. More things seem important to us and the area of ambiguity is larger. What more important than elections or atomic energy!!!

Professor Allport stated in his book that the elimination of rumors would be highly improbable. There would have to be more accurate and much more penetrating news coverage. People would have to find better explanations of the world in which they live. There would have to be fewer passions of hate and fear. Finally, there would have to be a remedy for the distortion that takes place, regardless of intentions of accuracy in the processes of retention, preception, and recall.

It is never safe to accept a rumor at its face value, for the kernel of truth that might be there is indistinguishable. Yet rumors are significant in that we can tell an awful lot about the people around us by the rumors they spread. By analyzing the rumors that we hear we can tell what is important to the individual who repeats it, something about his feelings of insecurity and what form they take.

For a more complete description of Professor Allport's work in this field, I suggest Professor Allport's very interesting book, "The Psychology of Rumor," published by Holt & Company.

plans for the future

(*Continued from page 23*)

The main entrance will be between the side sections and will embody a large reception room, a ladies' room, office and telephone exchange with an infirmary for the students. Besides this, there will be several double suites on this floor. In the two side sections there will be both double and single suites. On the upper floors of these sections will be mostly single suites with several doubles at the juncture of the sections.

The double suites are much the same as the present ones with a study, bedroom, and dressing compartment. In addition they will have built-in closets which the present dorms lack. Each room will have running hot and cold water as at present. One of the big improvements is that every room in the new dorms will have an outside connecting phone which will be reached through a main switchboard in the superintendent's office.

There will be a preponderance of single rooms according to the new scheme. These will be larger than the present rooms and will be about the size of the studies in the present double-room suites.

Where these dorms will be placed and whether they will be of this plan is not known, as these are the plans of Mr. Bemis, who has been working on the dormitory question for the last ten years and had these plans drawn up last January as a basis for the operations of the committee in charge.

THE FUTURE OF THE YOUNG ENGINEER at Western Electric is limited only by his own ability, by his vision to see what lies ahead and by his capacity to work for the goal he sets himself. Recent developments such as microwave radio relay networks for telephone calls and television programs – operator and customer dialing of long distance calls – automatic message accounting – new secret electronic equipment for the Armed Forces – promise an ever widening field for him.

MANY ENGINEERING TALENTS ARE REQUIRED. Most are used in creating plans, machines and technological methods to convert raw materials into thousands of different precisely manufactured articles. Here at Western, the engineer translates the stream of new designs from Bell Telephone Laboratories into terms of practical production. It is his job – a fascinating and satisfying one – to provide the ways and means of reproducing the laboratory model, as economically as possible, in whatever quantity the Bell Telephone System needs. And even after production is rolling, his efforts are unceasing in the search for improved methods, tools and materials which will result in a better product or a lower unit cost.

Western Electric

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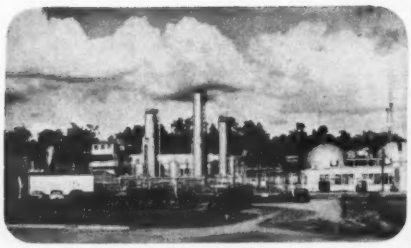

NEW PLANT MAKING AGRICULTURAL AMMONIA USES FRICK REFRIGERATION

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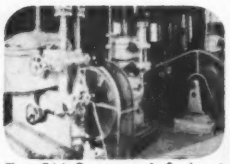

Three Frick Compressors in Service at the Mississippi Chemical Corp.

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Also Builders of Power Farming and Sawmill Machinery

the meson

(*Continued from page 10*)

In quantum theory, there are two types of statistics: Bose-Einstein, if more than one particle in a group of identical particles can occupy the same energy level; and Fermi-Dirac, if no more than one particle in a group can occupy the same energy level. These statistics determine the behavior of a group of specific particles on their interaction or close approach to each other. The fact that π-mesons obey Bose-Einstein statistics as predicted is a further boost to meson field theory. The field quanta on which electrical and gravitational forces are based obey Bose-Einstein statistics also. Therefore, there seems to be a relationship between field quanta (π-mesons) connected with forces in the nucleus and field quanta of the gravitational and electrical forces.

However, how do μ-mesons fit into the picture? They apparently are not related to nuclear forces. Just what is their function? Further complications arise when it is noticed that all mesons, both π and μ, spontaneously disintegrate in free space. The positive or negative π-meson decays into a positive or negative μ-meson and a neutrino in about 250 millionths of a second. The positive or negative μ-meson decays into a positive or negative electron and two neutrinos in about two millionths of a second. The neutral μ-meson decays into two gamma rays in about a hundred-millionth of a millionth of a second.

The importance of these instabilities and the function of the μ-meson is not known at the present time, since meson theory as a whole is not now very satisfactory. However, the distance of an antiproton (negative proton) can be more or less predicted from the rapid decay of the neutral π-meson into two protons. This is a result of the fact that because of its strong interaction with nuclear particles, the neutral π-meson should form a proton-antiproton pair, which will then destroy each other completely as a result of their interaction with the electromagnetic field, producing two photons in the process. Production of antiprotons will probably be possible when powerful enough accelerators are built.

Today a great deal of work is being done on cosmic rays in order to gain a better understanding of mesons and how they fit into the picture of fundamental particles. Here at M. I. T. the laboratory for nuclear science and engineering is also carrying on work on cosmic rays among other things. Several important experiments are taking place at the present time.

One of these is a balloon experiment on the "hard" component of cosmic rays. Cosmic rays have two components, a "soft" which is absorbed in about 10 cm. of lead, and a "hard" which can penetrate more than a meter of lead. The experiment is being carried out to study the nature of the "hard" component in the upper atmosphere. The apparatus was designed to separate the "hard" components into a group which does have a high probability of nuclear interaction in matter and a group that does not. The former group is composed mostly of nucleons (neutrons or protons) and π-mesons, and the latter of μ-mesons. Geiger-Mueller tubes forming coincidence circuits from which counting-rates are indications of altitude dependence of nuclear-interacting particles form the basis of the equipment used. Successful flights were carried out in July, August, and September of last year. The data from these flights is now being analyzed.

Another experiment being carried out is on the east-west effect of positive and negative mesons. The east-west effect is that influence which the magnetic field of the earth has upon particles approaching the earth. Positive and negative particles are deflected in different directions by the earth's magnetic field, positive particles being deflected towards the west, negative particles towards the east. Theoretical considerations suggest that it is a little harder for a slow positive primary particle to come in from the east than from the west. If the primaries are negative, the whole effect is just reversed. By collecting data on this effect it can then be decided what the nature of the primaries is (so far it seems that the primaries are protons). The equipment completed at M. I. T. for the experiment was first shipped to Echo Lake, Colorado in June, 1951. The main purpose of this high-altitude operation was a shakedown and calibration of the system before being sent to Bolivia. After considerable data was taken during the summer in Colorado, the equipment was shipped to Bolivia in September of last year, where work is to be carried on in La Paz and then Chacaltaya (17,000 feet), where it will operate for several months.

One of the other experiments concerns a high pressure cloud chamber operated at 200 atmospheres pressure, containing illuminated helium and beryllium as target for the beam of the synchrotron. This being used to collect data on meson reactions, the lifetime of the π^+-meson from first glance at the data appears to be about 2.5×10^{-8} sec. Another is the study of air showers with a multiple ionization chamber array, from which it is hoped that an analysis of ion-chamber pulse heights may clear up the structure of air showers near the shower core and through the density of ioniza-

(*Continued on page 44*)

Opportunities at General Motors

What the GM Organizational Setup Offers You—the Graduate Engineer

To understand your opportunity at General Motors you need to understand the General Motors setup.

GM is not only a major producer of motorcars and trucks. It is also a leading manufacturer of many types of civilian goods from heating systems to refrigerators, from fractional h.p. motors to Diesel locomotives.

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See December 1951 issue of Fortune Magazine for description of new multimillion dollar GM Research and Technical Center in Detroit.

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

help wanted

(*Continued from page 14*)

coded only as "president," "vice-president," etc., it was thought most logical to place managers and directors of specific activities with other alumni in that activity. Thus, sales managers are included in the general functional grouping of sales, production managers in production and so on. We see, then, that the administrative-management group does not include all alumni so engaged. This discrepancy is offset to an unknown degree by those alumni coded only as president, vice-president, etc., who are officers of very small companies and who spend a great deal of their time in actual selling, research, and other such functional activities. The president of Jones Motors, for instance, may be chief salesman, controller, treasurer and shop foreman all in one. So while we may have alumni who may be generally engaged in administration shown in other groups, we also have alumni classified as administrators-managers who may actually be primarily engaged in other functional activities.

The vocational activities of M. I. T. alumni are numerous and varied. There are doctors, lawyers, legislators, lecturers, clergymen, musicians, radio announcers, artists, curators and a host of others. While the greatest number are found in engineering and research positions, the majority are employed in a wide range of other positions. In the 1947 survey one hundred alumni reported they were engaged in health and medical activity at that time; ninety-seven were lawyers; 667 were teachers; 601 were presidents of various type institutions; 255 were sales managers; 126 were treasurers; 422 were works managers or superintendents of production — to name but a few of the 500-odd categories.

As shown on chart H, engineering and research leads in functional type of activity with 35.5% of the total. Alumni who described themselves only as presidents, vice-presidents, directors, etc., are placed in the management-administration group, accounting for 22.1% of all reporting alumni. If we were to include in this group all those in other executive and supervisory positions, such as superintendents, research directors, controllers, sales managers, and other functions related to management, the administrative-management group would lead all others, depending upon how far down the position-ladder one would go.

TABLE 2

BREAKDOWN OF THE ENGINEERING AND RESEARCH GROUP BY POSITION

Position	*No.*	*Per Cent of Group*	*Per Cent of Total*
Technical Director	58	1.4	0.5
Consulting Engineer	318	7.6	2.7
Chief Engineer	645	15.3	5.4
In Charge of Research	307	7.3	2.6
Design-Develop. Proj. Leader	147	3.5	1.2
Research Project Leader	190	4.5	1.6
Designer	1,590	37.9	13.4
Research Assistant	456	10.9	3.9
Process Development Engineer	148	3.5	1.3
Government Engineer	53	1.3	.4
Technician	89	2.1	.8
Others	207	4.7	1.7
Total	4,208	100.0	35.5

Further explanation should be made with reference to the "designer" classification that appears to dominate (37.9%) the engineering and research group, as shown on table 2. It is believed, from examination of the original records, that the designer classification was a type of "catch-all" for those alumni engaged in engineering who were difficult to code in any other category. In other words, an alumnus who neglected to state the title of his position was likely to be coded "designer" if other information gleaned from the questionnaire and the individual's records on file tended to support the classification.

Alumni engaged in electrical engineering and research activity were found to compose the single largest group within the general engineering and research functional grouping, with 19.4%. This was exceeded only by those designated as "other or unknown" (20.7%) who are, for the most part, graduates of other than the largest engineering departments who reported that they were employed in engineering or research capacities, but who did not state what *type* of engineering or research. The fact that very few graduates of the larger engineering departments were classified as being in activities different from their training at M. I. T. indicates one of two things. Either all alumni tend to find employment remarkably consistent with their field of training at M. I. T., or graduates of the larger engineering departments, such as mechanical engineering, were classified as being engaged in the type of engineering and research work for which they were trained at M. I. T. if they neglected to state what kind of engineering or research they were engaged in. The second assumption is thought to be of definite import.

The reader should be reminded, at this point, that no attempt is made herein to evaluate all data presented. Such an attempt would result in an extraordinarily long thesis and would necessarily be highly controversial in nature. Only those results deemed most significant are discussed, and these but briefly.

It is interesting to observe that no general functional grouping attracts, proportionately, more doctors than masters, more masters than bachelors, more bachelors than those with no degree from M. I. T. The inverse situation occurs, however, in the finance-accounting group and that group classified as "other," with a proportionately greater per cent of those alumni who did not graduate from M. I. T. engaged in these functions than bachelors, more bachelors than masters, and more masters than doctors.

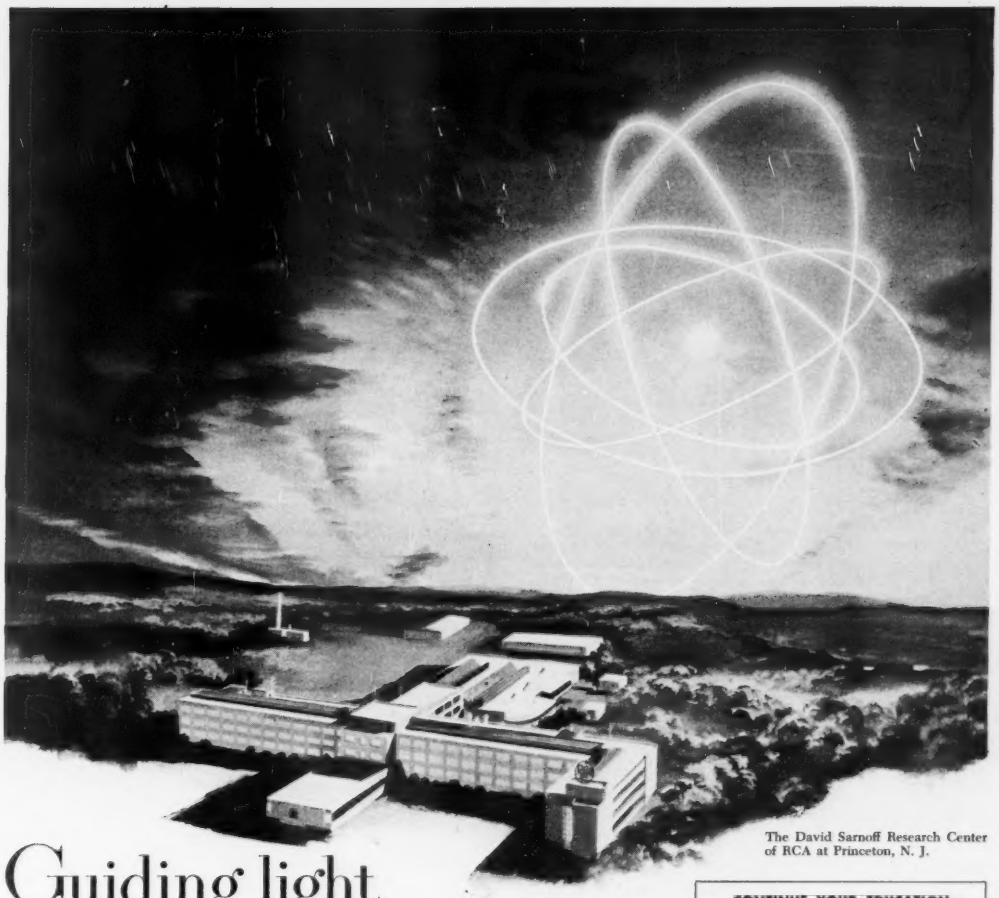
It is also interesting to see that only 10.9% of alumni with doctor's degrees are classified in the administration-management group compared to 25.1% of those with S.B. degree and 24.1% of those with no degree. This situation changes, however, when technical positions are considered.

The general functional patterns established by graduates of the Department of Mechanical Engineering are found to conform rather closely with the patterns established by the alumni as a whole. The largest percentage is found in the engineering and research category (42%) followed by the management-administration (23%) and production (11%) groups.

As a general rule, the oldest Course II graduates were engaged largely in administration and management, whereas over half of the younger graduates were engaged in engineering and research. This would indicate a general trend from technical to administrative positions with the experience of years.

Graduates of the Department of Chemistry deviate markedly, as one would suspect, from the functional patterns established by all alumni. It is no surprise to find 18.7% classified only as chemists. This does

(*Continued on page 38*)



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help wanted

(*Continued from page 36*)

not mean, of course, that only 18.7% are performing the function of a chemist. Many others may be engaged in chemical work but are classified in other groups — such as research or production, with 38%.

It is somewhat surprising to find that only 13.8% are included in the administration-management group compared to 22.1% of all alumni. We should point out again, however, that over 40% of Course V graduates studied have the doctor's degree. Graduates with a doctor's degree, as shown previously, tend not to go into administration-management — except technical administration — in nearly the proportion that bachelors and alumni with no M. I. T. degree do. It seems reasonable to assume, also, that graduates of the exact science departments are less interested in administration-management per se than in high technical and scientific achievement.

Engineering and research positions apparently attract a greater proportion of chemical engineers than any other group studied. Of the 1,242 Course X graduates who answered the 1947 questionnaire, 557, or 44.8%, were engaged in engineering or research at that time. Since only 35.5% of all alumni were engaged in these functions, it is evident that chemical engineers tend to find employment in the more technical positions.

More graduates of the Department of Business and Engineering Administration are engaged in management and administration (34%), as defined at the beginning of this section, than in any other function-group. Course XV graduates also find jobs in production (19%), sales (13%), and finance and accounting (7%) to a greater extent than the "average" alumnus. Less than one-half as many Course XV men reported being in engineering and research activity (16%), proportionately, as were reported by all alumni.

It is evident from data presented in this section and in the statistical supplement, that the kinds of jobs M. I. T. alumni attain and the nature of the work they perform virtually covers the waterfront of professional and business activity.

The large variation and concentration of the kind of work being done by graduates is revealed by the charts and tables developed. Although slightly over one-third of all alumni are engaged in the functions of engineering and research, the majority are engaged in other kinds of work and exhibit an impressive diversity of activities.

Primary determinants of whether or not the alumnus tends to be employed in engineering and research activity appear to be age, degree of specialization, and level of education attained at M. I. T.

Course II and Course X graduates tend to go into engineering and research jobs after graduation and move into administration and management as the years go by. These two function groups account for roughly

(*Continued on page 40*)

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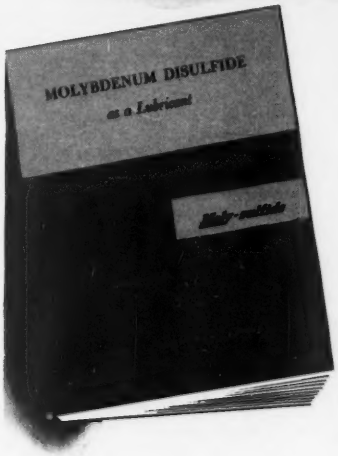

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MS 2 MIT-4

help wanted

(*Continued from page 38*)

65% of the graduates of these departments over the span of years studied, with the remaining 35% engaged in sales, production, teaching, and other functions.

Course V graduates tend to find employment in technical positions to a greater extent than graduates of other departments, with a smaller representation found in administration and management.

Production replaces engineering and research as the area of most opportunity for Course XV graduates just out of school. Here, too, the familiar tendency to gravitate to administration and management positions is clearly demonstrated.

One who sets out to attempt to answer the questions of how well alumni enter into, or remain in, a type of employment compatible with their training at M. I. T. soon runs into grave difficulties. He is faced (assuming that he has exact knowledge of the graduate's status) with such perplexing questions as: Is the position of the alumnus compatible with his training at M. I. T.? Is an alumnus in his field of training if he is engaged in a position such as salesman, which differs from his course of study, yet which necessitates his specific type of training? How broad or how narrow should one interpret the graduate's training to be?

It is clear that the answer to the question of how well alumni stay in their field of training depends wholly on interpretation and definition.

There is also some doubt that we possess exact knowledge of the graduate's status. The information supplied by the questionnaire was neither specific enough or comprehensive enough to determine, in all instances, the precise nature of the activity in which the alumnus was engaged, especially for those engaged in engineering or research.

The fact that only seven of 395 graduates of the Department of Mechanical Engineering who are classified as being consulting engineer, chief engineer, in charge of research, research project leader, design-development project leader, designer, draftsman, and estimator are shown in other than mechanical engineering leads one to conclude that either graduates of the Department of Mechanical Engineering do not shift to other types of engineering to any significant extent, or that Course II graduates were presumed to be in mechanical engineering unless information on the questionnaire seemed definitely to indicate otherwise.

Whether or not engineering graduates tend to shift to other fields of engineering we shall leave to future investigators with more detailed information. It is clear, however, that at least fifty per cent of Course II graduates go into some type of engineering and research, but that many gradually move into administration and management. Only 30% of the graduates out of school fifteen years or more are found to be in engineering and research.

If we define engineering and research to be the prime functions of mechanical engineers, we could say that 50% to 60% of Course II graduates go into the type of work for which they are specifically trained, but that the tendency is to move into other activity as the years go by.

On the other hand, if we define administration and management, production, teaching, and sales to be functions compatible with the individual's training, we must conclude that at least three out of four go into, and remain in, their field of training. More specific analysis than this would be unwarranted, in view of the general nature of the data used.

We might also investigate whether graduates tend to leave certain industry fields as they get older. Generally speaking, no significant correlation exists between fields of activity and age (or years out of school). That is not to say that there is no continuous movement from one field to another, but only that older graduates do not tend to concentrate in particular fields to any significant extent.

The field of aeronautics apparently attracts a greater proportion of younger graduates than the older, as does the field of insurance. It is interesting to note that a much larger proportion of the alumni who graduated in the depression years of 1930–35 were in federal service than graduates of other year-groups. This may indicate a tendency for graduates to remain in a particular field once entered.

A similar investigation was made to see if graduates of other departments tend to move into particular fields as they become older. No clear-cut trend was evident. In no case did the writer find progressively greater representation in a major field according to age. Because of this, charts showing the composition of industry fields according to age-groups were not developed for other departments.

Graduates of the Department of Chemistry apparently remain in their field of training to a greater extent than do graduates of the other departments studied. Chemists tend to remain in technical positions, with 40% of those out of school twenty-five years or more classified as being in engineering and research or as "chemist."

An even greater proportion of those graduates of Course V with master's and doctor's degrees are found to be in technical positions, with approximately 70% thus employed. It seems reasonable to conclude, then, that graduates of this department go into, and remain in, activity closely associated with the type of training received at M. I. T. This conclusion is confirmed by Course V placement advisors.

The proportion of graduates of the Department of Chemical Engineering (S.B. Degree) who were engaged in engineering and research activity in 1947 dwindles from 60% of those out of school two to three years to around 24% of those out 15 years or more. Here, again, we find that the administration-management group absorbs most.

The functional patterns established by graduates of Course X conforms so closely to those patterns established by Course II graduates that the same analysis of the tendency to do work compatible with the training received at M. I. T. applies.

In Course X, too, we find that the higher the degree received at M. I. T., the greater the tendency to go into technical positions.

Graduates of Course XV are most difficult to evaluate of all. It is obvious that the broad training available to students of this department makes it difficult indeed to decide whether or not the graduate is engaged in activity compatible with his field of training. The writer is convinced that no such analysis can be made, with accuracy, without either qualifying statements so closely, or making them so general, as to be of little value.

In general, the writer is of the opinion that the overwhelming majority of Course XV graduates go into, and remain in, positions in which direct applications of this individual's training at M. I. T. is made. This, of course, is a broad enough statement, and serves to illustrate the contention made above.

One need only to scan the curriculum established

(*Continued on page 44*)

This is a magnification of what abrasive material?

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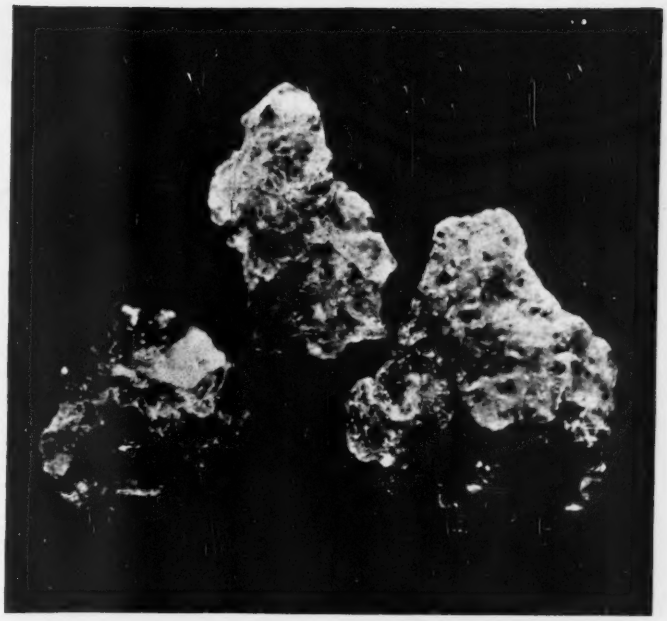

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Gordon R. Finlay, Ph.D., Cornell '42, examines a specimen with the Metallograph in the Physical Testing Laboratory at the Norton electric furnace plant in Chippawa, Canada.

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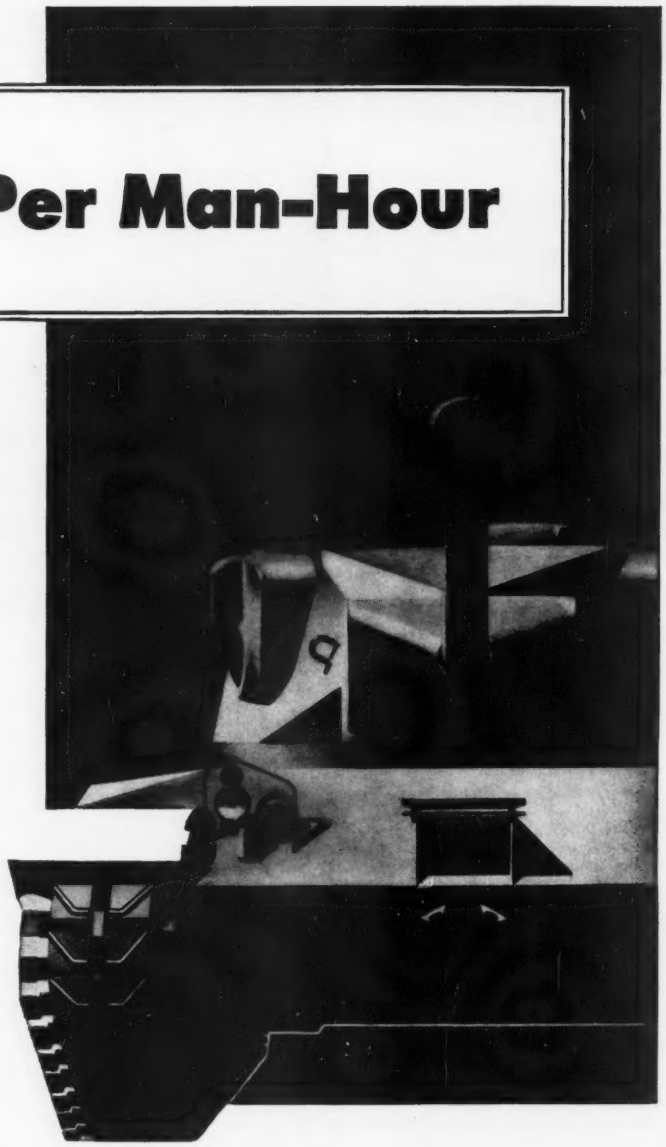

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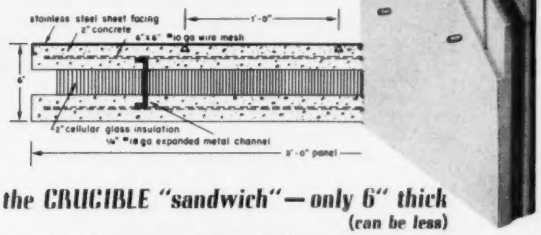
What's Happening at CRUCIBLE

about stainless curtain walls

Modern construction methods have changed walls from the self-supporting type to a mere covering which does not support its own weight for more than one or two stories. Hence the definition of "curtain wall":—the facing or enclosure of the structural steel frame. This frame supports the entire weight of modern buildings.

The need has existed for a covering that would not only clothe the building, but be lightweight, economical and space saving. Because these requirements are more than adequately met with stainless steel curtain wall construction, this method is becoming increasingly popular with cost and space conscious owners, builders and architects.

the CRUCIBLE "sandwich"



the CRUCIBLE "sandwich" — only 6" thick (can be less)

Crucible stainless steel curtain wall panels are in the form of 6-inch thick "sandwiches". The facing consists of flanged, light-gauge stainless steel sheets with a factory, or site-fabricated, sandwich consisting of cellular glass insulation between two layers of concrete with connecting reinforcing. Crucible 18-8 stainless as the outside face offers excellent resistance to weather and fire while providing eternal beauty with a minimum of maintenance; the inside face can be finished or painted to suit the requirements of modern building interiors. Since 18-8 is restricted in use, a good substitute material, type 430 stainless, now government decontrolled, offers the same benefits as 18-8 stainless.

moisture penetration

The unique characteristics of the cellular glass insulation stop moisture vapor migration from one face of the panel to the other. The cellular insulation properly designed and installed assures that condensation will not take place *anywhere* within the sandwich.

insulation

Although less than half as thick as the usual wall construction, this Crucible stainless steel panel construction has more than twice the insulating value. The "U" value (overall thermal conductivity) is approximately 0.15 BTU Hr./Sq.Ft./°F.

fire resistance

The Crucible sandwich met the requirements of a standard 4-hour fire test conducted in the testing laboratories of the National Bureau of Standards. This meets all old building codes and is double, or better, the requirements of modern enlightened building codes.

erection and fabrication

Since a building frame is not precision built, the attachment of the panel walls to the frame is done with fastening devices that provide necessary 3-dimensional adjustment. Panels can be made at the building site, and a 24-hour casting-to-fastening cycle is possible.

technical service available

Though the use of some stainless steel is now restricted, Crucible metallurgists and development personnel are continuing to investigate improved methods of curtain wall and other construction so that better buildings can be built when stainless is more freely available. For more information write: CRUCIBLE STEEL COMPANY OF AMERICA, General Sales and Operating Offices, Oliver Building, Pittsburgh, Penna.

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industry's rubber carpets

(*Continued from page 16*)

veyor belt moving at one and one-half miles per hour. Beside this platform are small ten-passenger wheelless cars, resting on a conveyor belt moving the same speed as the platform. The passenger enters one of these cars. As each car passes the end of the platform, its door closes. It then passes over a series of accelerating wheels which increase the car's speed to fifteen miles per hour and pass it onto the main conveyor belt travelling at that speed. As the car approaches Grand Central Station, it passes onto a set of decelerating wheels which decrease its speed to one and one-half miles per hour and puts it on a conveyor moving at that rate. The car door opens, and the passenger steps out of the car onto a platform moving at the same speed, and leaves the station. The car, meanwhile, passes around a large turning wheel onto the loading conveyor moving in the other direction. It is estimated that twenty-five cars will pass the loading platforms each minute. The estimates cost is $2,100,000.

The advantages claimed over the present rail shuttle are: (1) elimination of "batch loading" and crushing crowds, (2) faster movement of passengers, (3) greater safety, due to the elimination of large crowds, (4) lower maintenance costs.

The lowly conveyor belt has now moved into the big league transportation business, and we can look forward to seeing more and more material carried by conveyors in the years ahead.

the meson

(*Continued from page 34*)

tion of each event perhaps help to locate the core and to estimate its energy. The application of the theory of multiple scattering to the study of ionizing particles passing through the plates of a multiple plate cloud chamber with the possibility of identifying the mass of particles that stop in the chamber after going through a sufficient number of plates is a third project.

For all of this work that is being done on cosmic rays and mesons, though, there is still no adequate meson theory which today can give a good explanation of nuclear forces. Several variations on the meson theory of nuclear forces, and several theories on the nature of the meson itself, have been advanced. However, none of these theories has had any great success. It is probable that any future theory of matter will have to distinguish between protons and electrons as stable particles and the many unstable particles, such as π- and μ-mesons.

help wanted

(*Continued from page 40*)

for students of the various departments to see that the courses of study are not the specialized courses offered in a "trade" school, but basic and fundamental courses from which may be gained an awareness of much more than techniques.

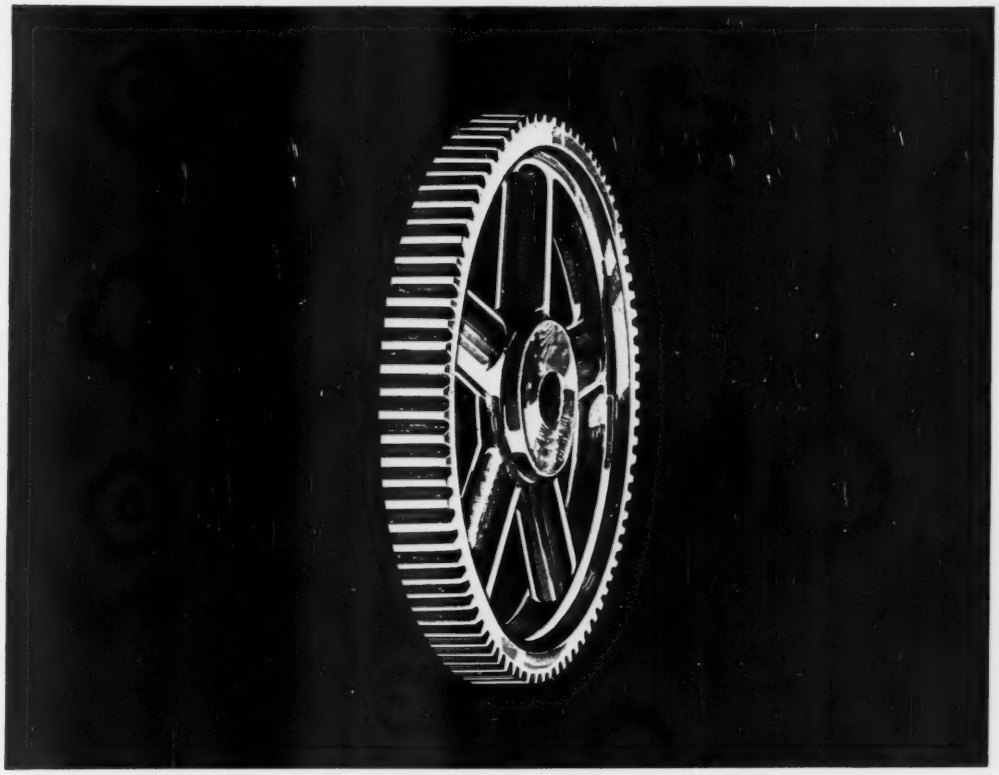
The answer to the question of whether or not graduates of M. I. T. tend to go into, or remain in, types of employment compatible with the type of training received at M. I. T. rests squarely on what one deems to be "compatible" and on what one considers the graduate to be trained for. It becomes a matter of degree. In general, the writer firmly believes that most graduates go into positions that call for performance in activities which are directly in line with the type of training received at M. I. T. It should be reiterated that the writer places a liberal interpretation on what the graduate is trained for, believing that the training at M. I. T. does not restrict one to a narrow field of endeavor, but is equally valuable in a wide variety of activities.

pi

(*Continued from page 17*)

$$AE = OA\frac{13}{5}\sqrt{1+\left(\frac{11}{5}\right)^2} = 6.2831839\ldots \text{ x radius}$$

So AE is less than the circumference by less than two millionths of the radius. The quadration is completed when a square is constructed equal to $\frac{1}{2}\,AE \cdot OA$. Certainly, from the practical standpoint, this is as accurate a quadration as we could ask. The error involved is imperceptible. But theoretically, there is an error, and no matter how close we get to quadraturing the circle, we will always have some error.



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HEADQUARTERS FOR BUSINESS INFORMATION

women's dorm

(*Continued from page 12*)

As I mentioned before, there are various jobs to do here. Each girl is supposed to spend about two hours a week doing such things as setting the table, washing dishes, or cooking breakfast. The girls are expected

A friendly session breaks up the tension.

to clean their own rooms and make their own beds if they want them so. Every so often it is necessary to spend an evening answering the telephone. Fortunately there is a bell ringing system with a certain signal for each girl. Unfortunately, however, the Institute has not seen fit to install a phone in each room and so a girl who lives on the fourth floor becomes extremely agile at leaping down the stairs.

If one doesn't eat breakfast it is not necessary to have to cook or wash dishes then, but apparently this doesn't hold for supper; this is a fact I am extremely annoyed with, because it obliges me to go home for supper to do dishes even if there is something going on at school I want to go to, and there are many things I'm interested in at school. The boys certainly don't have this trouble unless they belong to a fraternity. But the girls' dorm is not a sorority, so why must it have to have the disadvantages of both sororities and dorms? The women's dorms compare unfavorably with the International House at Berkeley, at which I stayed for one summer. There the girls enjoyed the freedom of a hotel, food as good as here, and at much lower prices. One wonders why this cannot be duplicated here.

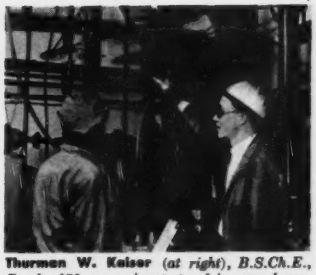
In all fairness we must note that the rules are not as bad as those of many girls' dormitories. They do not make the place a prison, and indeed if they did no one would continue living here. Perhaps it is not surprising that all of them are easier to state in the negative, and a large part of them concern boys — no boys above the first floor, no boys in the house after two on Saturday nights, i.e., Sunday mornings, and no boys after eleven other nights. There is one recent rule of special interest — that is that no couple may lie on the floor together. This refers to lying on the living room rug usually in front of a fire, which I imagine can be quite aesthetic. There are two obvious objections to this rule. First, outsiders hearing of the rule will be informed of the possibility of the practice, for merely having the rule implies this has been abused enough to require one. Second, it encourages the girls to retire dangerously to their boy friends' rooms. Of course there are other minor rules such as no scotch tape on walls, no using light bulbs over one hundred watts, no using the shower after eleven or before seven, and no moving furniture from floor to floor. We also have a sign-out book which we are supposed to use if we intend to be out after ten-thirty. We are not supposed to have liquor in the house, but that doesn't matter; we can always get it elsewhere if we want to.

There are perhaps some conveniences in living at the dorm which one might not find elsewhere. A lot of girls would not find it convenient to cook for themselves, and make a few other small arrangements if they lived in rooms by themselves or with other girls. We have a sewing machine which I find very useful because I like to make some of my own clothes. We also have a washing machine in the basement. Next to the laundry room in the basement there is a room which is used for playing ping-pong and studying; one wall is covered with coeds' names and handprints in paints of practically every color; I haven't contributed mine yet. There are a few other conveniences such as newspapers, magazines, and records to play. Of course there are other girls, some of whom find each other necessary for group purposes; they are also convenient for obtaining such things as forgotten assignments.

(*Continued on page 50*)

Printed at the insistence of our photographer.

THE DU PONT DIGEST



Thurmen W. Kaiser *(at right), B.S.Ch.E., Purdue '50, supervises tests of improved process for making neoprene intermediates.*

[FOURTH OF A SERIES]

Ch. E's at Du Pont

Plant development work is solid background for a future in chemical engineering

The work of production supervisors at Du Pont, as discussed here last month, is aimed at getting better results from existing processes and equipment.

In contrast, the job of plant development groups is to find ways to improve methods and products, and advise management when changes should be made for economic or technical reasons. Chemical engineers in this work are responsible for lowering process costs, adapting the product to new uses and improving product quality to obtain a larger share of the existing market.

These duties provide an understanding of the fundamental aspects of the business, as well as a broad view of Company operations. The training and experience a man gains as a member of a plant development group—often a first assignment at Du Pont—is an excellent background for any field he may move into later.

Conducting a development study usually involves obtaining data from laboratory, semi-works and plant-scale experiments, estimating profits and investments, and consulting with sales, research and production personnel, also with auxiliary departments such as Engineering, Chemical and Purchasing, and with outside authorities.

H. E. Graham, Jr., *B.S.Ch.E., Georgia I. T. '48, and* **J. F. Carley,** *Ph.D.Ch.E., Cornell '51, study a plastic compounder-extractor-extruder for improvements in making plastics.*

Here are typical problems solved by plant development groups:

John Purdom, *B.S.Ch.E., Ohio State '49, and* **Kenneth Kehr,** *B.S.M.E., North Carolina State '50, discuss diagram of a process for improved recovery of a nylon intermediate.*

1. Prompted by obsolescence and wearing of equipment, experimental studies and economic comparisons were made on the entire process of isolating dyes. Methods in use called for crystallization, filter pressing and tray drying. It was found that a rotary vacuum filter with a continuous rotary steam tube dryer, air conveyor and a dust collection system reduced costs about $50,000 a year.

2. Production of sodium silicate was to be increased substantially, but the tank-type furnace at the heart of the process proved a bottleneck. The furnace design, including exit and entry ports, was improved, and its capacity enlarged at a small fraction of the cost of a new furnace.

Reid Earnhardt, *B.S.M.E., Cornell '44, M.S.M.E., Carnegie '48, and* **René M. LeClare,** *M.S.Ch.E., M. I. T. '51, check installation of improvements in plant equipment.*

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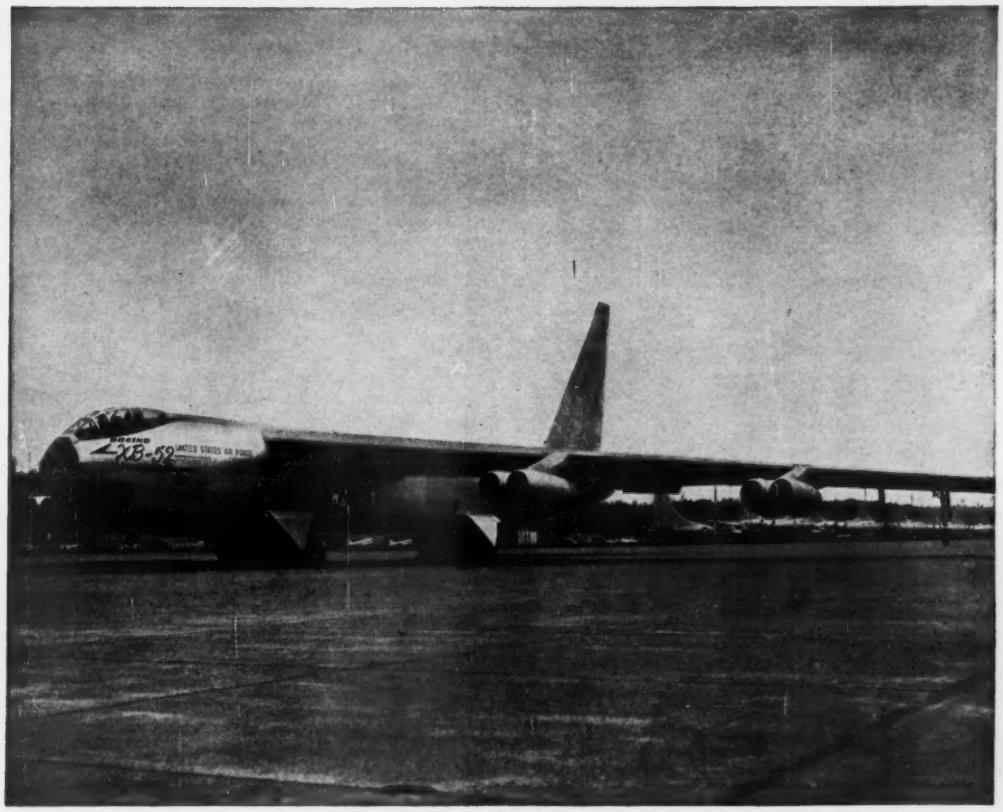

Engineering secrets are under her skin

This is the first official photo of the giant Boeing eight-jet XB-52. It's America's new all-jet heavy bomber, and another trail-blazing product of Boeing engineering leadership. Still highly classified, Boeing's most revolutionary developments are out of sight, under the XB-52's gleaming skin.

The B-52, vital to America's defense plans, is just one of the challenging projects Boeing engineers are at work on. Others include guided missiles, supersonic research, and the B-52's team-mate, the six-jet B-47 medium bomber, now in quantity production.

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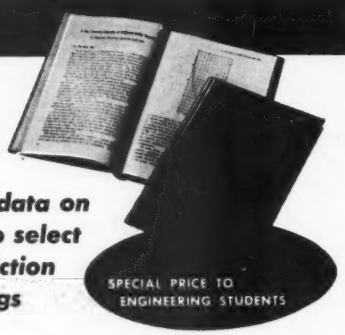

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the miracle

(*Continued from page 19*)

some of the material in the neighborhood of one of the early churches. This church was devoted to Saint Sebastian, and the priest offered as a theory, perhaps not too well substantiated but perfectly probable, that the pieces of metal he had dug up were relics; in fact, probably some of the original arrows of Saint Sebastian.

I don't know just the process by which the engines of the death of Saint Sebastian acquired special miraculous powers, but we have the True Cross as a prototype, and relics are of the most divers character. The miracle of Joshua, when he made the sun stand still, was a really good-sized one; but within the frame of science there are minor miracles as well. Now, to upset scientific experiment at all requires a very small miracle indeed, and with a devout and faithful servant praying to Saint Sebastian in the direct presence of his arrows, what can one expect? After all, as we understand it, the Saint was a Roman soldier, and the very special needs of the modern scientist must be well beyond him. The needs of an eloquent and faithful though simple soul are matters much more suited to his comprehension.

We have no complete evidence that this is what happened. However, since then I have noticed on the part of the Boss a distinct disinclination to use any material emanating from a quasi-clerical source. I don't think he is any more religious than he was before, but he is very much annoyed, and last year when there was a question of hiring a fellow by the name of Sebastian as laboratory boy, the youngster lost the job. And I am very sure I know why.

At any rate, the moral of this little tale, if there is any moral, is that saint and scientist should each stick to his own business. Meanwhile, the janitor Sebastian flourishes, and I believe that in his self-satisfaction he is beginning to grow his moustachios again.

women's dorm

(*Continued from page 46*)

Many of the girls are exceptional, and there certainly are some types you don't find here. You don't find many of the overly frivolous type, the type that tries to outdress the other girl, or the type that thinks prestige is gauged by how frequent dates you get, but on the whole they're as bad as any bunch of coeds. I have never lived with such a conceited criticizing lot, but maybe I feel this way because I am a freshman and look young, for I have noticed that other girls will make the same occasional mistakes as I do and are not criticized for it. I also have the feeling that many girls here have the notion that self-denial is noble; this is a conception I'm afraid I cannot appreciate, as their particular form of it does not exist for me. I'm apt to think it's all tommyrot designed to win other people's admiration. Of course there are other types of girls besides the kind with a desire to shove other people around. There are a few of the essentially kind type who are much to be admired and seldom found. There are one or two conformists with puritan ideals, who are barren of most intellectual pursuits other than their studies, who would rather be boys and yet deny themselves of boys' privileges. There are more with various contrasting tendencies. I sometimes wonder how many of them really enjoy the life at Tech and how many have only succeeded in persuading themselves they do.

This car replaced 615 "Bottles"

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In 1927, a chemical manufacturer asked us, "Why must some chemicals be handled in small drums or carboys . . . can't tank cars be built of aluminum?"

From our years of research, we knew that we had alloys compatible with many chemicals—and experience in fabrication methods dictated welding. The Field was inviting, and we decided to design and pay for the first aluminum tank car ourselves.

Our engineers designed an 8,000-gallon tank, to be welded together from 16 large aluminum plates. Working with a leading tank car builder, lessons which we had learned in other Alcoa developments enabled us to materially assist in the alloys selected, welding techniques and structural fabrication methods employed. One year later, in 1928, the car was completed. It was then tested in 20,000 miles of road service, while hauling glacial acetic acid—a typically tricky cargo. It weathered 3,500 recorded shocks—900 severe ones. That aluminum car is still in service!

Together with tank car builders, we have developed improved riveted and welded car designs, which are now "standard." Today there are over 1,300 aluminum tank cars carrying the fussy compounds that formerly traveled only in small containers.

This is typical of the development jobs we do at Alcoa. Others are under way now and more are waiting for mechanical, metallurgical, electrical, chemical and industrial engineers having the imagineering skill to tackle them. Perhaps you may be one of those men. ALUMINUM COMPANY OF AMERICA, 1825 Gulf Building, Pittsburgh 19, Pa.

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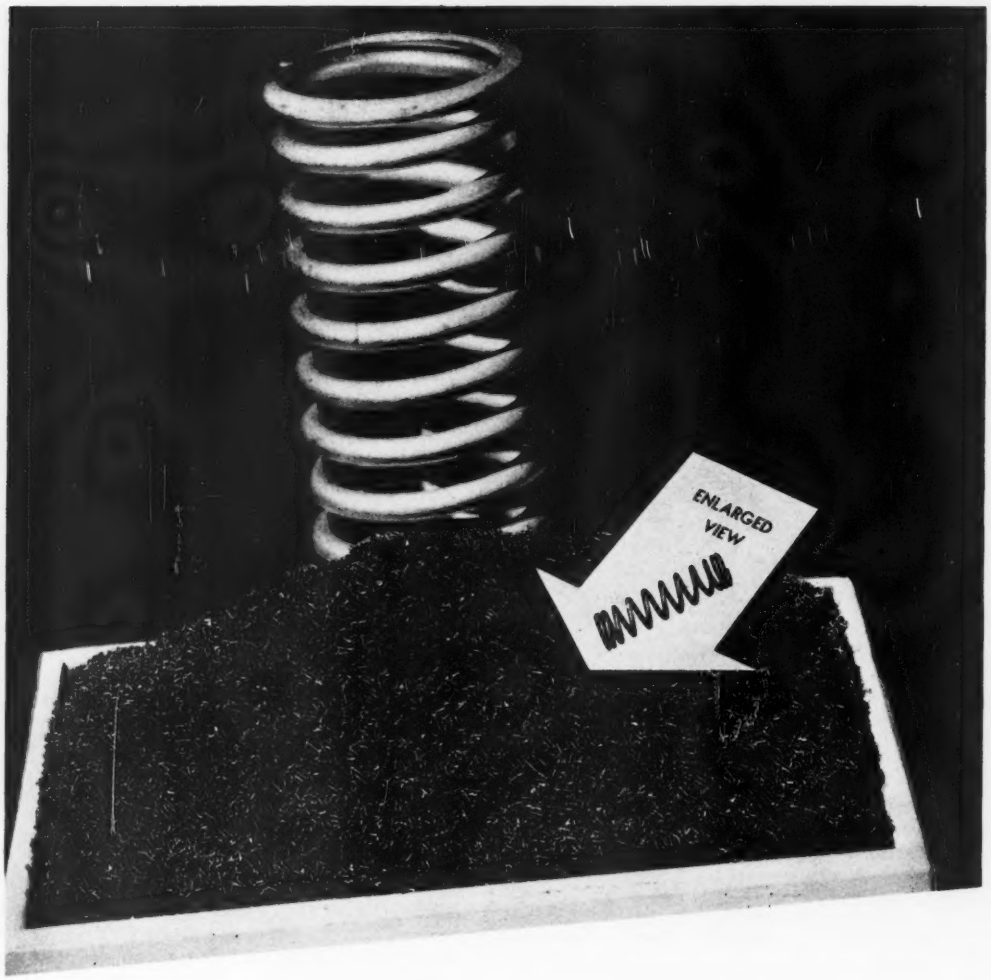

We wouldn't recommend counting them, but there are 177,000 compression springs piled in the tray above. Their total weight is 2½ pounds. By comparison, the single large compression spring also weighs 2½ pounds. Extremes of spring usage like these are an everyday occurrence—in greater or lesser degree. They are the reasons why springmaking is one of the most interesting and stimulating industries.

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Springmakers for four generations

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The name doesn't matter—

only the meaning of Free Enterprise

Some people say we should get a new name for it. Perhaps. But what does the name matter, so long as we preserve the meaning. A good thing, too, to review what it means once in a while:

It means Hope. Your boy can start a business or hope to boss the one he's in . . . In countries without free enterprise only the government owns and runs a business.

Free enterprise means Decency . . . In so-called "liberal" countries where "everything is for the people," you can be thrown into a slave labor camp to die, just on the whim of some enemy.

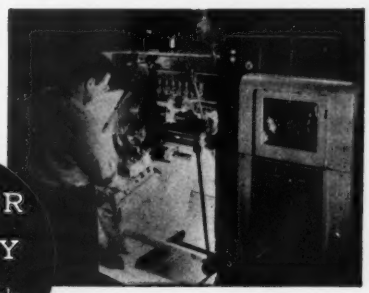
It means Home . . . not two families "assigned" to one room.

It means Courage . . . and no need to cringe at the words "police" or "party member".

It means Dignity . . . not sobbing out a "confession" in a courtroom to avoid more torture.

It means Education. Read what you want . . . not what some official decides for you. (And much of your reading may be made possible, by the way, by a Scotch immigrant boy named Carnegie who made millions under the American free enterprise system, and spent them on free libraries.)

Free enterprise—Americanism—profit-and-loss system . . . the *name* doesn't matter so long as you are on the alert against the people who are trying to change and destroy its *meaning*.



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briefing the news

Compressed Air Cutting . . .

A "cutting wind," produced by a knife blade moving faster than the speed of sound, is being used to cut thin slices of almost everything from asbestos to zinc by a scientist of the General Electric Research Laboratory.

Although a knife blade is used, its primary purpose is to produce a small pocket of compressed air immediately preceding the knife. It is believed that air does the actual cutting, rather than the knife itself.

The blade is mounted in the whirling wheel of a laboratory device called a high-speed microtome.

As the wheel whirls at 65,000 revolutions per minute, the knife blade is propelled at a calculated tip speed of 1,200 feet per second, or at the supersonic speed of more than 818 miles per hour. Speed of sound is about 750 miles per hour.

The blade's supersonic speed is believed to produce a small pocket of compressed air which tears materials on a submicroscopic scale. This action leaves a smooth surface on the face of the cut, through which the knife easily passes.

This "sharp air" technique is used for cutting asbestos, cork, bone, mica-insulation, metals, wood, plastics and many other items.

The instrument was primarily designed for cutting extremely thin cross-section specimens of materials for study under an electron microscope. Because of the blade's tremendous speed, the microtome has cut what is believed to be one of the thinnest slices ever made, a metal shaving less than two-millionths of an inch thick, or about 1,000 times thinner than a human hair.

Submicroscopic sections produced by the microtome are invisible to the naked eye. In fact, the sections are so small that they can be studied in detail only under an electron microscope. This type of microscope magnifies the original size about 25,000 times; and larger magnifications can be obtained by photographing the specimen at a predetermined magnification and then enlarging the picture. It is said that a human hair enlarged 25,000 times would be larger than a giant redwood tree.

In attempting to obtain ultra-thin sections, scientists experimented many years with cutting instruments. Evidence that air can apparently cut was first noted in early experiments with this present instrument, when it was found that blades were not dulled by cutting.

"Since perhaps it is the air that does the cutting, sharpness of the knife should not be too important, except to produce a very small area of compression," said the G. E. scientists.

In cutting, the microtome blade moves through objects in the same fashion as a knife through butter. The instrument's knife has a slicing effect, instead of the chipping action of a saw.

Material to be cut enters the knife's path from the side, by means of a small pencil-shaped device. The method is likened to that of bologna being fed into a meat slicer at a delicatessen.

No cutting noise is heard during operation, since according to theory, air, rather than the blade, is doing the cutting. Only the motor's shrill humming can be heard.

The laboratory instrument has a cutting blade mounted in a three and three-eighths inch diameter wheel. Powered by a "souped-up" one-third horsepower electric motor, the wheel can be rotated up to 65,000 revolutions per minute. This terrific rotational velocity is necessary to produce the pocket of compressed air.

Razor blades were formerly used as cutting edges in most laboratory experiments, not because of their sharpness, but because a razor's fine edge is more suitable for building up a thin area of compression.

Blades now used are especially designed for the instrument. In order to obtain a thinner area of compression, however, he manually sharpens blades to a keener edge. Thinner blades result in smaller cuts. Sometimes a very thin wire is used for a cutting edge.

Centrifugal force, produced as the wheel rotates at supersonic speeds, adds considerable stiffness to a wire. In fact, it is believed that at these speeds, wire so thin as to be barely visible to the naked eye, will become as stiff as a one-sixteenth inch diameter steel bar.

Among few materials which the instrument cannot successfully cut are rubber and vitallium, the latter being one of the hardest of metals.

Rubber could be cut if it were first frozen with liquid nitrogen, or vulcanized to a more brittle state. The hard metal could be cut if more air could be obtained through greater rotational velocity of the wheel.

About a dozen high-speed microtomes of his design are in use throughout the country.

Economy in Mining ...

Gases now wasted in coal mining may eventually be utilized in producing power, with the aid of turbines similar to those used in jet aircraft. This prediction has been made recently by Sir Alfred Egerton of the University of London.

When coal is mined, he explained, some of the coal's energy escapes as methane gas. Though this is only about one per cent of the total energy, he added, it may still be a large amount of power, and if it could be utilized, it might be able to supply a large part of the power required in the mine.

Present methods sometimes employed, of burning some of the gas under boilers to make steam, salvage only a fraction of the energy that is now wasted. It is suggested that a gas turbine might provide part of the solution of the problem. Such turbines operate in a manner similar to steam turbines, where a blast of high-temperature steam drives a windmill-like rotor. In the gas turbine, instead of steam, hot gases from the burning fuel are directed against the turbine blades.

In the method proposed by the British scientist, some of the air pumped into the mine for ventilating purposes would be preheated to a temperature at which methane would burn, and thus, when mixed with the gas, combustion would take place. Then the hot gases would drive the gas turbine. The hot exhaust would be used to preheat additional air needed for the burning process.

Whether this would be feasible depends on whether the methane would burn rapidly enough, and for that reason he already has conducted experiments on the rate of burning of very fast moving streams of methane and air.

It was found that if air and methane, at a concentration of five per cent, are separately heated to about 1,800 degrees F., burning takes place about five thousandths of a second after they are mixed, which is rapid enough to use the method.

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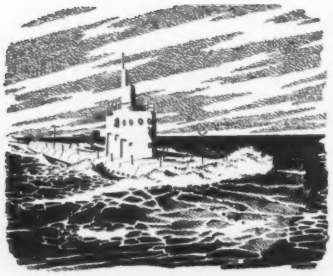

It's a tense moment aboard a U. S. Navy submarine when the signal for diving stations electrifies the crew.

And to make sure all preparations have been *properly* made for a swift, safe descent—submarines are equipped with a panel of colored lights like the one shown below aboard the *U.S.S. Silversides*. Submariners call it the "Christmas Tree," because when all valves and hatches are closed the whole panel glows green.

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Aladdin and the "Al Kali"

You remember the story of Aladdin and his magic lamp. But what never came out in Arabian Nights was the probability that Aladdin might well have used "al kali" to cleanse and polish the old lamp, when he made the discovery of its magic properties.

The origin of soda ash—oldest of the major industrial chemicals—is veiled in antiquity. Its history goes back at least 5,000 years through the civilizations of many peoples. In various parts of the world the ashes of plants were leached to obtain soda. One of the plants so used by the Arabians was kali, and their term for soda, al kali, became our word alkali.

The miracles of modern industrial chemistry of course far surpass the magic of Aladdin's lamp. Many of these industrial processes and products employ alkalies to bring to our civilization a multiplicity of refinements undreamed of even a few short years ago. As one of the nation's leading producers of alkalies and related chemicals, Columbia-Southern salutes the achievements of the industries it serves.

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a chemical of many uses

Although soda ash was first utilized for its cleansing powers—and soap making continues to be an important usage—other uses have long exceeded the original. Soda ash is a basic ingredient of glass, this being the largest single use; but soda ash is also essential to so many chemical processes that, in the aggregate, this is the largest market. Virtually every industry uses soda ash to some extent and the following are merely indicative of its versatility: water treatment, metals refining, pigments, pulp and paper making, textiles, petroleum refining, ceramics, leather tanning. A complete list of all processes involved would fill a good-sized book!

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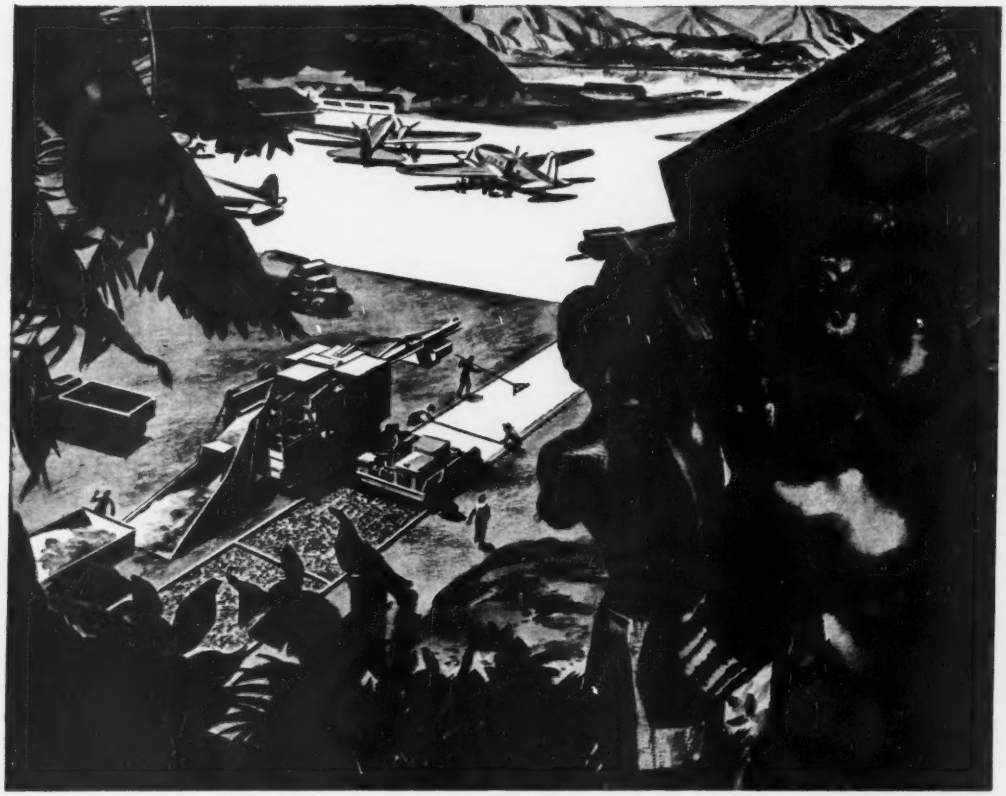

Takes a lot to lay a carpet in the jungle

The scene is "darkest Africa".

But Africa is lightening. Man's quest for minerals, for new areas for agriculture and trade, is slashing ultra-modern, glaring-white air strips in once impenetrable jungle.

Those pavers, portable air compressors, pumps and air tools—such as you might see working a city street—are Worthington Blue Brutes going to "lay a carpet" in that hole in the jungle.

Thus, Worthington, a major producer of equipment for public works, industry and farm, brings the fruits of American technical genius to the strange places of the world.

And illustrates, too, how the unique American talent of *diversification* helps public, employees and stockholders. For Worthington makes many things—not just construction equipment and pumps, but also engines, water works machinery, power transmission, petroleum equipment, air conditioning and refrigeration, many others.

Such diversification builds *stability* . . . makes Worthington, 112 years old, a strong link in the chain of American business.

Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Harrison, New Jersey.

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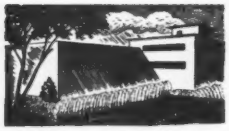
The Sign of Value Around the World

1.14



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Lower-Cost Manufacturing—pumps compressors • steam turbines • motors power transmission • air conditioning

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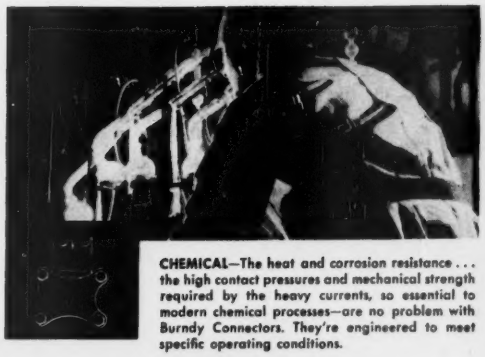
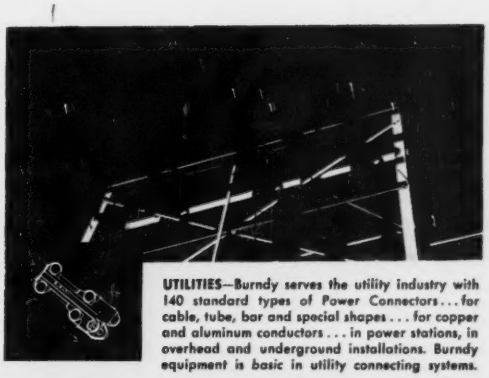
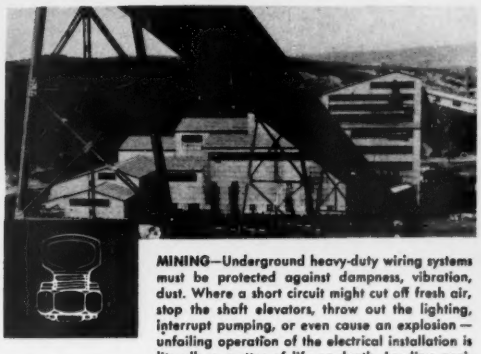
you'll find Burndy connectors on the job!



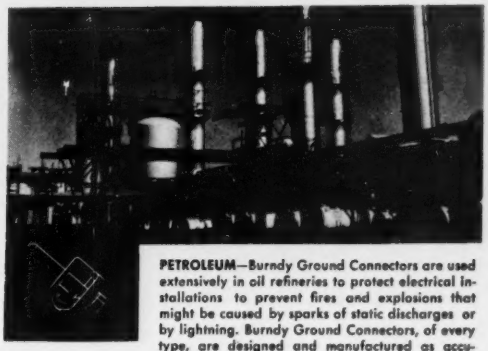
CHEMICAL—The heat and corrosion resistance... the high contact pressures and mechanical strength required by the heavy currents, so essential to modern chemical processes—are no problem with Burndy Connectors. They're engineered to meet specific operating conditions.



UTILITIES—Burndy serves the utility industry with 140 standard types of Power Connectors... for cable, tube, bar and special shapes... for copper and aluminum conductors... in power stations, in overhead and underground installations. Burndy equipment is basic in utility connecting systems.

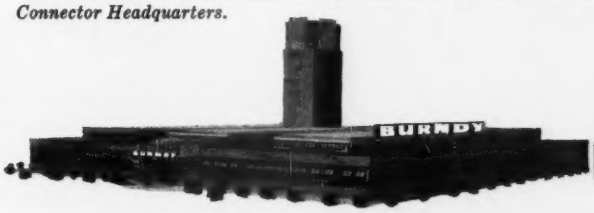


MINING—Underground heavy-duty wiring systems must be protected against dampness, vibration, dust. Where a short circuit might cut off fresh air, stop the shaft elevators, throw out the lighting, interrupt pumping, or even cause an explosion—unfailing operation of the electrical installation is literally a matter of life or death. Leading engineers specify Burndy Connectors.



PETROLEUM—Burndy Ground Connectors are used extensively in oil refineries to protect electrical installations to prevent fires and explosions that might be caused by sparks of static discharges or by lightning. Burndy Ground Connectors, of every type, are designed and manufactured as accurately as those which are called on to carry current continuously.

Burndy Connectors are specified because of their superior performance in joining, terminating, clamping, and grounding every size and functional variety of electrical conductor—from the smallest home wiring circuit to the largest industrial installations. Burndy engineering is continuously developing more and more efficient connecting methods. *Engineering graduates and students are welcome visitors at Burndy Connector Headquarters.*



BURNDY

BURNDY ENGINEERING COMPANY • NORWALK, CONNECTICUT • BURNDY CANADA LTD., TORONTO, ONT.
WORLD'S LARGEST MANUFACTURER OF ELECTRICAL CONNECTORS"

Massachusetts Institute of Technology

CAMBRIDGE, MASSACHUSETTS

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY
offers the following Professional Courses:

SCHOOL OF ARCHITECTURE AND PLANNING

Architecture

City Planning

SCHOOL OF ENGINEERING

Aeronautical Engineering

Building Engineering and Construction
- Options: Heavy Construction
  Light Construction

Business and Engineering Administration
- Courses: Based on Physical Sciences
  Based on Chemical Sciences

Chemical Engineering

Chemical Engineering Practice

Civil Engineering
- Options: Theory and Design
  Planning and Administration
  Construction and Management

Economics and Engineering
- Options: Human Relations
  Industrial Economics

Electrical Engineering
- Options: Electric Power
  Electrical Communications
  Electronic Applications

Electrical Engineering
Co-operative Course

General Engineering

Marine Transportation

Mechanical Engineering
- Options: Power
  Materials, Design and manufacturing
  Automotive

Mechanical Engineering
Co-operative Course

Metallurgy
- Options: Metallurgy
  Mineral Engineering

Meteorology

Naval Architecture and Marine Engineering

SCHOOL OF SCIENCE

Chemistry

Food Technology

Food Technology — Five Year Course

General Science

Geology
- Options: Geology
  Geophysics

Mathematics

Physical Biology

Physics

Quantitative Biology

The duration of each of the above undergraduate Courses is four academic years and leads to the Bachelor's degree, with the following exceptions: (1) Architecture and Marine Transportation, which are five-year courses leading to the Bachelor's degree; (2) Food Technology (Five Year Course), Physical Biology, and the Cooperative Courses in Electrical Engineering and in Mechanical Engineering, which extend over a period of five years and lead to the Bachelor's degree and the Master's degree.

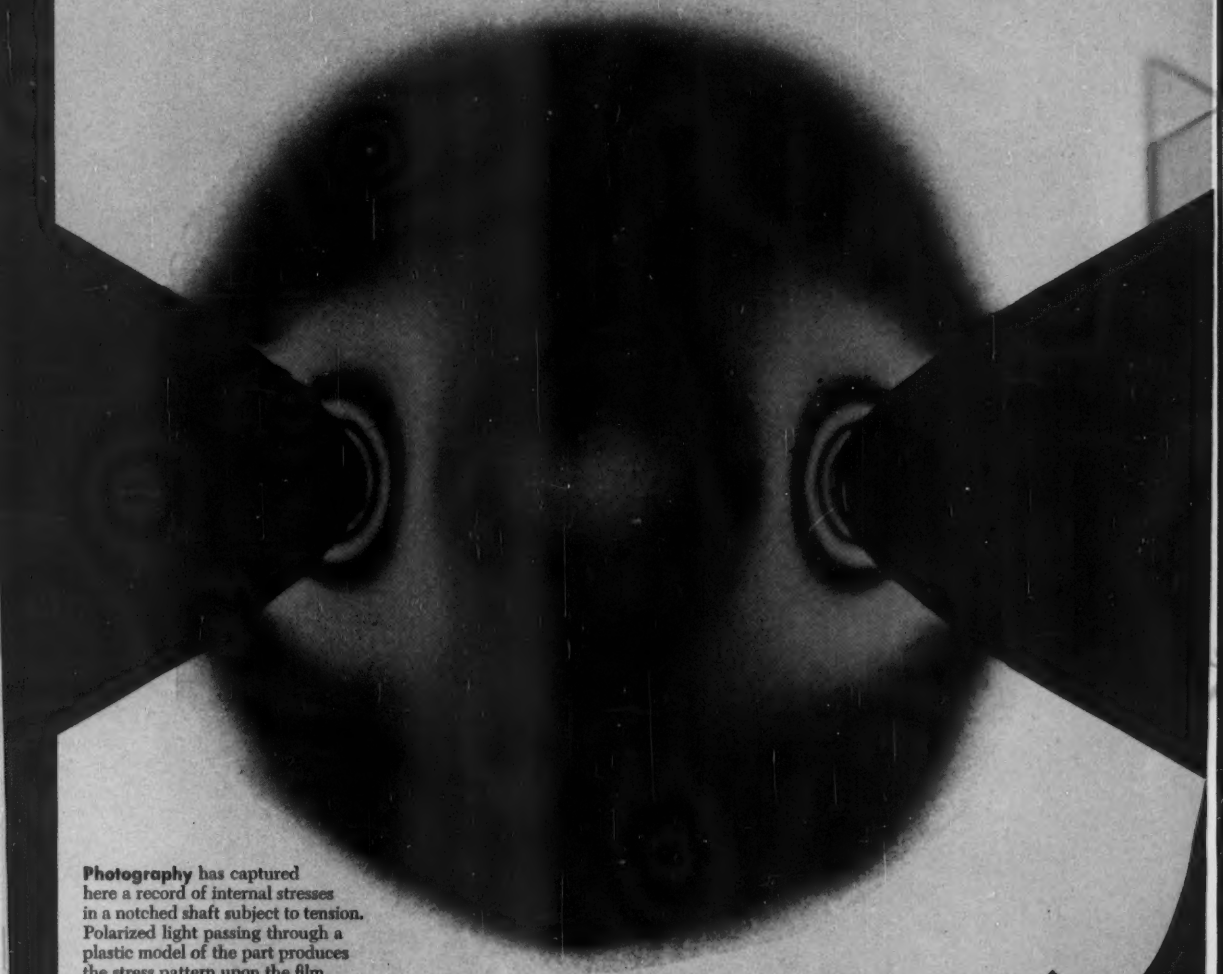
Graduate study may be pursued in Textile Technology, Ceramics, Sanitary Engineering, and in most of the above professional Courses. The Master's and Doctor's degrees are offered in most of these fields.

For information about admission, communicate with the Director of Admissions. The Catalogue for the academic year will be sent free on request.

Photography gives engineers quick, accurate facts

● In routine work—in unique applications—engineers find photography can supply information obtainable in no other way. It can show you internal stresses in machine parts—you see what modifications in design will increase strength and reduce weight. You can study fast motion by slowing it down with high speed movies. You can record the flick of the cathode-ray trace or get accurate records of other instrument readings.

Photography is already aiding engineering in many important ways, and new applications are being made every day. This has led graduates in the physical sciences and in engineering to find positions with the Eastman Kodak Company. If you are interested, write to the Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N. Y.



Photography has captured here a record of internal stresses in a notched shaft subject to tension. Polarized light passing through a plastic model of the part produces the stress pattern upon the film.

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WE ASKED GRADUATES TEN YEARS OUT OF COLLEGE:

WHAT MADE YOU DECIDE ON A CAREER WITH GENERAL ELECTRIC?

This advertisement was written by G-E employees who graduated ten years ago—long enough to have gained perspective, but not too long to have forgotten the details of their coming with the Company. These graduates were sent a questionnaire and were requested to return it unsigned. Their answers, listed below in order of mentions, give an informative appraisal of G.E. as a place to work and as a source of career opportunities.

1. G-E TRAINING PROGRAMS

Sample quotes: "I knew that G.E. offered the best training courses." "Liked the idea of rotating assignments and courses." "Wanted to take advantage of the training courses." "G.E. had a training plan which would let me choose a job after reasonable time for investigating jobs available in the Company." "I felt that Test (Test Engineering Program) would make the easiest transition from school to work." "I felt that I would get the best kind of electrical engineering training if I went with G.E." "The Test course appealed to me because of its combination of continued technical instruction plus practical experience on the test floor."

2. VARIETY OF OPPORTUNITIES

"Why does a youngster run away with a circus?" "Believed it was a good chance to find the field I liked best as I wasn't quite *sure* what type of work I wanted to get into." "G.E. goes out of its way to find the corner you are happiest in and best suited for." "The varied opportunities of work let you change jobs without leaving the company." "Only company which offered a job where an engineer could be in on design, sales and application—i.e., 'application engineering.'" "Promise of varied experience made it unnecessary to decide on a particular specialty until I had more opportunity to look the field over."

3. GENERAL ELECTRIC'S REPUTATION

"G.E.'s prestige and reputation appealed to me." "G.E. was more favorably disposed to the coming war effort and was doing work directly contributory." "High caliber persons with whom to work." "Reputation for technical excellence." "G.E.'s reputation as a good employer." "Because with the name of G.E. went a sense of security." "I felt that G.E. was the leader in the electrical field and I wanted to take part."

4. CONSIDERATE TREATMENT

"The only offer I received was from General Electric—other companies interviewed would not consider me because of my reserve officer status." "Among the companies offering jobs to college graduates in 1941, G.E. seemed to take more of a personal interest in its new men." "The G-E representatives made me feel they were interested in *me*."

For a free booklet, "Planning Your Career," a description of such G-E training programs as the Test Engineering Program, Business Training Course, Manufacturing Training Program, Chemical and Metallurgical Program, the Physics Program and Sales Training programs, write to General Electric Co., Dept. 221B-6, Schenectady, N. Y.

You can put your confidence in—

GENERAL ELECTRIC